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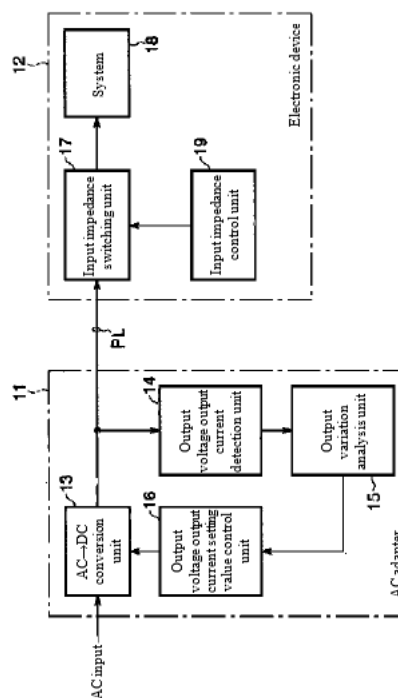
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(54) [Title of Invention] ELECTRONIC DEVICE AND AC ADAPTER

(57) [Abstract]

[Problem] The present invention provides an electronic device and an AC adapter capable of realizing an automatic device specification recognition function and an output power source matching function, with which a stable operating power source can be continuously supplied in accordance with device specifications to multiple types of devices having different power input specifications, without having to make available AC adapters specific to each device, and with which the AC adapter generates and outputs an operating power source in accordance with the specifications of the device body, without requiring a dedicated control signal line and without causing noise influence on device operation.

[Solution] When an AC adapter 11 is connected, an electronic device main body 12 varies the impedance on a power output line (PL) for a certain period of time to notify the AC adapter 11 of the power input specifications of the device itself. The AC adapter 11 recognizes the power input specifications of the power supply target device based on the notification by impedance variation from the device main body 12, and generates and outputs an operating power source according to the output specifications corresponding to the recognized input specifications.



[SCOPE OF THE PATENT CLAIMS]

[Claim 1] An electronic device operable by an AC adapter power source, comprising means for notifying the AC adapter of device power specifications by temporarily varying the impedance of a power output line of the AC adapter.

[Claim 2] The electronic device according to claim 1, wherein, at the time of initial power supply from the AC adapter to the device main body, the device main body varies the impedance on the power line to which the power is supplied according to predetermined conditions, and the AC adapter analyzes the content of the impedance variation on the power supply line to recognize the power input specifications of the device main body and outputs power corresponding to the specifications on the power supply line.

[Claim 3] The electronic device according to claim 2, wherein the device main body varies the impedance on the power line for a certain period of time according to a frequency, duty, or digital value determined by external power input specifications.

[Claim 4] An electronic device comprising a device main body and an AC adapter supplying an operating power source to the device main body, wherein the device main body is provided with: a power input terminal for inputting power output from the AC adapter; a secondary battery charged under at least constant current control or constant voltage control by the adapter power supplied to the power input terminal; a main circuit operating with the adapter power supplied to the power input terminal or the secondary battery as an operating power source; and impedance control means for varying the impedance of the power input terminal for a certain period of time when the AC adapter is connected to the power input terminal to notify the AC adapter of the power input specifications of the device main body; and the AC adapter is provided with: a stabilized power supply circuit; means for detecting current or voltage changes accompanying impedance variations at the power output terminal of the power supply circuit and recognizing the power input specifications of the device main body from the detected value; and a power control circuit for controlling the stabilized power supply circuit according to the recognized power input specifications to generate power corresponding to the power input specifications and output control the power from the power output terminal.

[Claim 5] The electronic device according to claim 4, wherein the AC adapter outputs power for information exchange at a low power and low voltage level that does not reach the operating power voltage of the main circuit of the device main body at the power output terminal until the AC adapter recognizes the power input specifications of the device main body by impedance variation at the power output terminal or for a predetermined period, and the device main body performs an impedance variation operation for notifying the power input specifications of the device while receiving the power for information exchange at the low power and low voltage level.

[Claim 6] The electronic device according to claim 5, wherein the device main body has a secondary battery having storage means for holding power management information, and varies the impedance of the adapter power input terminal for a certain period of time based on the power management information of the storage means built into the secondary battery to notify the AC adapter of the adapter power input specifications of the device main body.

[Claim 7] An AC adapter for supplying an operating power source to an electronic device, comprising means for recognizing the power input specifications of the electronic device as a power supply target from

the content of impedance variation on the power supply line, and means for generating power according to the recognized specifications and outputting the power on the power supply line.

[Claim 8] The AC adapter according to claim 7, comprising means for recognizing the power input specifications of the device main body by impedance variation on the power supply line; means for outputting power for information exchange at a low power and low voltage level that does not reach the operating power voltage of the main circuit of the device main body on the power supply line until the power input specifications of the device main body are recognized by impedance variation on the power supply line or for a predetermined period; and means for outputting power corresponding to the recognized specifications on the power supply line when the power input specifications of the electronic device as a power supply target are recognized from the content of impedance variation on the power supply line.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention] The present invention relates to an electronic device operable by an AC adapter power source, and an AC adapter supplying an operating power source to the electronic device. Furthermore, the present invention relates to an electronic device and an AC adapter provided with a function for switching the power output specifications of the AC adapter according to the power input specifications of the device main body.

[0002]

[Prior Art] Conventionally, in electronic devices operable by an AC adapter power source such as portable personal computers, dedicated AC adapters having unique standards were required for each model and furthermore for each type of built-in secondary battery.

[0003] Therefore, conventionally, there existed the problem that a dedicated AC adapter had to be made available for each type of electronic device and each type of secondary battery. On the other hand, there exist, as identification technology for AC adapters in this type of conventional device, configurations in which a dedicated signal line for AC adapter identification is provided (JP H2-261888 A (Software Notification Type Battery Charging Method), JP H8-168185 A (Battery Charger)), as well as configurations in which a specific signal voltage is synthesized into the DC output of the AC adapter and separated on the device side (JP H7-143749 A (AC Adapter and Device Using AC Adapter)).

[0004] Among these technologies, in the configuration in which a dedicated signal line for AC adapter identification is provided to identify the AC adapter, a dedicated signal line for AC adapter identification and a connector terminal for connecting the signal line are required in addition to the DC power supply line between the AC adapter and the device, and, accordingly, the adapter cable becomes large in diameter and restrictions are imposed on the connector connection means, resulting in poor usability and structural complexity, which is a problem. Furthermore, since the number of parts in the exterior structure increases, careful handling is required, and contact failure of the connector and disconnection of the signal line are easily caused, resulting in reliability problems.

[0005] Further, in the configuration in which a specific signal voltage is synthesized into the DC output voltage of the AC adapter and separated on the device side, a signal synthesis circuit is required on the AC adapter side, and a signal separation circuit is required on the device side, resulting in circuit configuration complexity. Furthermore, since a specific signal voltage is superimposed on the DC voltage serving as the operating power source, when this configuration is applied to precise electronic devices such as personal

computers that are susceptible to noise, the signal voltage becomes a noise source and causes malfunction. Therefore, there has existed the problem that this configuration cannot be adopted for electronic devices susceptible to noise such as personal computers.

[0006]

[Problems to be Solved by the Invention] As described above, conventionally, in electronic devices operable by an AC adapter power source such as portable personal computers, dedicated AC adapters having unique standards have been required for each model and furthermore for each type of built-in secondary battery, and therefore there has existed the problem that a dedicated AC adapter had to be made available for each type of device or each type of secondary battery.

[0007] Moreover, among the conventional AC adapter identification technologies, in the configuration in which a dedicated signal line for AC adapter identification is provided, a dedicated signal line for AC adapter identification and a connector terminal for connecting the signal line are required in addition to the DC power supply line between the AC adapter and the device, and, accordingly, the adapter cable becomes large in diameter and restrictions are imposed on the connector connection means, resulting in poor usability and structural complexity, which is a problem. Furthermore, since the number of parts in the exterior structure increases, careful handling is required, and contact failure of the connector and disconnection of the signal line are easily caused, resulting in reliability problems. Furthermore, among the conventional AC adapter identification technologies, in the configuration in which a specific signal voltage is synthesized into the DC output voltage of the AC adapter and separated on the device side, a signal synthesis circuit is required on the AC adapter side, and a signal separation circuit is required on the device side, resulting in circuit configuration complexity, and since a specific signal voltage is superimposed on the DC voltage serving as the operating power source, when this configuration is applied to precise electronic devices such as personal computers that are susceptible to noise, the signal voltage easily becomes a noise source causing malfunction, and therefore, there exists the problem that this configuration cannot be applied to electronic devices susceptible to noise such as personal computers.

[0008] The present invention was devised in view of the above circumstances, and has as an object to provide an electronic device and an AC adapter capable of supplying and controlling a stable operating power source always according to the device specifications to multiple types of devices having different power input specifications, without making available an AC adapter specific to each device in an electronic device operable by an AC adapter power source.

[0009] Furthermore, the present invention aims to provide an electronic device and an AC adapter capable of realizing an automatic recognition function of device specifications and a matching function of output power source, in which, by connecting an AC adapter to the device main body in an electronic device operable by an AC adapter power source, the AC adapter generates and outputs an operating power source according to the specifications of the device main body, without requiring a dedicated control signal line, and without causing noise influence on device operation.

[0010]

[Means for Solving the Problems] The present invention is such that, in an electronic device operable by an AC adapter power source, when an AC adapter is connected to the device main body, the impedance of the power line of the AC adapter is varied for a certain period of time to notify the AC adapter of the power input specifications of the device itself. Furthermore, the present invention is such that the AC adapter

recognizes the power input specifications of the device to be supplied with power based on the information notification by impedance variation from the device main body, and generates and outputs an operating power source according to the output specifications corresponding to the recognized input specifications.

[0011] By having such an automatic recognition function of device specifications and a matching function of output power source, it is possible to supply a stable operating power source continuously in accordance with the device specifications to multiple types of devices having different power input specifications, without making available an AC adapter unique to each device, and to continuously supply a stable operating power source according to the device specifications, without requiring a dedicated control signal line and without causing noise influence on device operation.

[0012] Specifically, the present invention is an AC adapter provided with an output specification switching function and an electronic device having an external power input function receiving an operating power source from the AC adapter, wherein the output specifications of the AC adapter are switched by varying the input impedance of the electronic device for a certain period of time, without requiring a control signal line.

[0013] This power input impedance switching means of the electronic device first changes the output voltage or output current of the AC adapter on the device side, and the AC adapter side detects "1" (H) or "0" (L) from the change in the voltage or current. The AC adapter recognizes the input specifications of the device by identification information (digital data) based on the combination of "1" and "0," or identification information (period data) in which the frequencies (periods) of "1" and "0" are different, or identification information (duty data) in which the duty cycles of "1" and "0" are different, and switches the output specifications.

[0014] As a result, on the device side, the signal to the power line is output only during a partial period before receiving the regular operating power source from the AC adapter, and since no other control signals are superimposed on the operating power source received from the AC adapter, there is no risk that noise accompanying the signal synthesis might affect the operation of the main circuit via the power line. Therefore, even when applied to noise-sensitive electronic devices such as portable personal computers, highly reliable and stable operation can be expected.

[0015] Also, when the output specifications of the AC adapter do not match the input specifications of the electronic device, or when there is no variation in the input impedance of the electronic device for identifying the AC adapter, the AC adapter stops output or reduces the output voltage, current, etc., to a predetermined value or less, thereby eliminating inconveniences caused by mismatch between the AC adapter and the device.

[0016]

[Embodiment of the Invention] An embodiment of the present invention will be described below with reference to the drawings. Figure 1 is a block diagram showing a main configuration of the entire electronic device including the AC adapter according to the embodiment of the present invention.

[0017] In the figure, 11 is an AC adapter, and 12 is an electronic device main body. 13 to 16 are components constituting the AC adapter 11, 13 is an AC→DC conversion unit that converts external commercial AC power to DC power, 14 is an output voltage/output current detection unit that detects impedance variation on the output line (PL) of the AC adapter 11 connected to the output terminal of the AC→DC conversion unit 13 as a voltage value or current value, 15 is an output variation analysis unit that analyzes the type of

identification information (digital data/period data/duty data) and the data content (specification number) from the content of output impedance variation on the power output line (PL) based on the detection output of the output voltage/output current detection unit 14, and 16 is an output voltage/output current setting value control unit that switches the set values of output voltage and output current of the AC adapter 11 according to the power input specifications of the connected electronic device main body 12 based on the analysis result (specification number) of the output variation analysis unit 15.

[0018] 17 to 19 are components constituting the electronic device main body 12, 17 is an input impedance switching unit that controls switching of the input impedance of the power output line (PL) of the AC adapter 11, 18 is a main circuit unit (system) of the electronic device main body 12 operating with the DC output power of the AC adapter 11 as the operating power source, and 19 is an input impedance control unit that switches (on/off) the input impedance switching unit 17 for a certain period according to the power input specifications of the device itself when the AC adapter 11 is connected and the regular operating power source has not yet been received (referred to as device specification recognition mode).

[0019] Note that this impedance variation on the power output line (PL) of the electronic device main body 12 may be performed by means for performing same for a predetermined time when the AC adapter 11 is connected, or by means for performing same until the switching of the output specifications of the AC adapter 11 is completed and the AC adapter 11 switches from the low voltage specification recognition mode to the normal operation mode according to the device specifications.

[0020] For example, the AC adapter 11 outputs power for information exchange at a low power and low voltage level (for example, a constant voltage of about 5V to 6V) on the power output line (PL) as a device specification recognition mode until the AC adapter 11 recognizes the device specifications of the electronic device main body 12 by the impedance variation on the power output line (PL), and the electronic device main body 12 performs impedance conversion for announcing the device specifications for a certain period while receiving power for information exchange at the low power and low voltage level. Thereafter, the AC adapter 11 recognizes and sets the device specifications by the impedance conversion, and outputs power (for example, a constant voltage of about 15V to 18V) according to the set device specifications on the power output line (PL). Alternatively, while receiving power for information exchange at the low power and low voltage level from the AC adapter 11, the device specification recognition mode performs impedance conversion for notifying the device specifications, confirms reception of power according to the device specifications (for example, a constant voltage of about 15V to 18V), and stops the impedance variation operation.

[0021] In the configuration shown in Figure 1, when AC power is supplied to the AC adapter 11, the AC power is converted into DC power by the AC→DC conversion unit 13 and supplied to the electronic device main body 12 via the power output line (PL). At this time, since the AC adapter 11 is still in a state of not having received information for recognizing the power specifications of the device by impedance variation from the connected device, power of a predetermined small power low voltage value (a voltage significantly lower than the operating voltage of the system 19) is output on the power output line (PL) as a power source for information exchange under the device specification recognition mode.

[0022] When the electronic device main body 12 receives the predetermined small power low voltage value power for information exchange from the AC adapter 11, the electronic device main body 12 varies the

impedance on the power output line (PL) for a certain period according to the power input specifications of the device itself to announce the AC adapter 11 of the power input specifications of the device itself.

[0023] In other words, in the electronic device main body 12, when the input impedance control unit 19 recognizes that power for information exchange at a predetermined low voltage is supplied on the power output line (PL), the input impedance switching unit 17 is switched (on/off) according to the power input specifications of the device itself by a predetermined identification information type (digital data/period data/duty data) for a certain period, thereby varying the impedance of the power output line (PL). This variation of the input impedance causes the output impedance of the AC adapter 11 to vary.

[0024] The AC adapter 11 detects this output impedance variation by the output voltage/output current detection unit 14 and analyzes the content of the output impedance variation with the output variation analysis unit 15. Based on the analysis result of this variation content, the output voltage/output current setting value control unit 16 switches the set values of the output voltage and output current of the AC adapter 11 according to the power input specifications of the connected electronic device main body 12.

[0025] After changing the set values of the AC adapter 11, the input impedance control unit 19 stops switching the input impedance by the input impedance switching unit 17, and power according to the device specifications is supplied to the system 18 as the operating power source.

[0026] Specific examples of impedance variation according to the identification information type (digital data/period data/duty data) at this point, as well as examples of setting the device specifications and power output according to the device specifications, will be described later with reference to Figures 6 to 12.

[0027] Next, a specific configuration example of the AC adapter 11 is shown in Figures 2 and 3. Figure 2 shows a first embodiment of the AC adapter 11 having the above functions, and in the first embodiment shown in Figure 2, a configuration example is shown in which recognition of the specifications by impedance variation is realized by detecting current variation.

[0028] When AC power is input to the AC adapter 11, the AC power is rectified and smoothed by a bridge diode and a capacitor of a front-stage rectifier circuit 101 included in the AC→DC conversion unit 13 shown in Figure 1, and converted to AC/DC.

[0029] The DC power output from the front-stage rectifier circuit 101 is attenuated (voltage/current conversion) by a switching circuit 105 and a transformer 102 included in the AC→DC conversion unit 13, and rectified and smoothed by a diode and a capacitor of a rear-stage rectifier circuit 103 included in the AC→DC conversion unit 13, and output on the power output line (PL).

[0030] At this time, the output voltage and output current are detected by voltage dividing resistors 107 and 108, a current detection resistor 106, a voltage error amplifier 115, a current error amplifier 112, etc., included in the output voltage/output current detection unit 14 shown in Figure 1, and the detected values are sent (fed back) to the PWM control unit 104.

[0031] The PWM control unit 104 performs PWM (pulse width modulation) control of the switching circuit 105 based on the detected values of the output voltage and output current. This PWM control performs stabilization control of the output power.

[0032] Here, the detection of the output voltage is performed by inputting voltage data (ed) obtained by dividing the output voltage by the voltage dividing resistors 107 and 108 into the voltage error amplifier 115.

[0033] Also, the detection of the output current is performed by amplifying the voltage across the current detection resistor 106 by an amplifier 111, and inputting the current value (id) to the current error amplifier 112, comparator 117, and timer 110.

[0034] The current error amplifier 112 compares this current data (id) with a reference voltage (e2), and inputs the comparison result value as current comparison data (ic) to the voltage error amplifier 115.

[0035] The voltage error amplifier 115 performs the following operations (a) and (b) based on the magnitude relationship between the current comparison data (ic) and the voltage data (ed).

Operation (a)

When the output current value (id) detected across the current detection resistor 106 is equal to or less than the output current setting value set by the reference voltage (e2), the current comparison data (ic) is not sent to the voltage error amplifier 115.

[0036] In this case, the voltage error amplifier 115 compares the voltage data (ed) with the reference voltage (e1) of the reference voltage setting unit 116. Therefore, the voltage comparison data (ec) output from the voltage error amplifier 115 is the comparison result with the voltage setting value set by the reference voltage (e1) of the reference voltage setting unit 116.

[0037] The voltage comparison data (ec) output from the voltage error amplifier 115 is sent to the output voltage/output current setting value control unit 109 constituting the output voltage/output current setting value control unit 16 shown in Figure 1 and the PWM control unit 104.

[0038] The PWM control unit 104 recognizes the current output based on this voltage comparison data (ec), and performs stabilized output control by PWM controlling the switch 105. Specifically, when the output current value is equal to or less than the current setting value, the output voltage becomes the output voltage setting value.

[0039] Operation (b)

When the above output current value exceeds the output current setting value set by the reference voltage (e2) of the reference voltage setting unit 113, the current comparison data (ic) is output to the voltage error amplifier 115.

[0040] In this case, the voltage error amplifier 115 compares [voltage data (ed) + current comparison data (ic)] with the reference voltage (e1) of the reference voltage setting unit 116. Therefore, the voltage comparison data (ec) output from the voltage error amplifier 115 is the comparison result at a value smaller than the voltage setting value (reference voltage (e1)) set by the reference voltage setting unit 116 by the amount of the current comparison data (ic).

[0041] The voltage comparison data (ec) output from the voltage error amplifier 115 is sent to the output voltage/output current setting value control unit 109 and the PWM control unit 104. The PWM control unit 104 recognizes the current output based on this voltage comparison data (ec), and performs stabilized output control by PWM controlling the switch 105.

[0042] As a result, the output voltage decreases by the amount of the current comparison data (ic). Specifically, when the output current value exceeds the current setting value, current limiting is applied and the output voltage changes.

[0043] The diode 114 prevents unnecessary current circulation of the voltage data (ed) input to the current error amplifier 112. In this embodiment, as shown in Figure 9, there are two current limits. One is a current limit value (1) for preventing overcurrent, and the other is a current limit value (2) for constant current

charging of the secondary battery when the electronic device main body 12 is provided with a secondary battery. Switching between the current limit value (1) and the current limit value (2) is realized by the timer 110 switching the set value of the reference voltage setting unit 113, that is, the reference voltage (e2).

[0044] The switching between the current limit value (1) and the current limit value (2) is carried out:

(a) When the output current is equal to or less than the current limit value (2), the reference voltage (e2) of the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (1).

[0045] (b) When the output current exceeds the current limit value (2), after a predetermined time elapses, e.g., 6 seconds after exceeding the current limit value (2), the reference voltage (e2) of the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (2).

[0046] Next, the output specification switching control of the AC adapter 11 will be described. The comparator 117 compares the reference voltage (e3) of the reference voltage setting unit 118 with the current data (id), and when the reference voltage (e3) of the reference voltage setting unit 118 is less than or equal to the current data (id), it sends "1" to the output voltage/output current setting value control unit 109. When the reference voltage (e3) of the reference voltage setting unit 118 is greater than the current data (id), it sends "0" to the output voltage/output current setting value control unit 109.

[0047] The output voltage/output current setting value control unit 109 detects the impedance variation on the power output line (PL) by the electronic device main body 12 from this "1" and "0," and switches the reference voltage value (e1) of the reference voltage setting unit 116 and the reference voltage values of the current limit value (1) and the current limit value (2) switched by the timer 110 according to the variation content.

[0048] Besides the above embodiment, cases such as controlling by inputting the voltage comparison data and current comparison data respectively to the PWM control unit 104 without using the timer 110, limiting the output voltage in constant current output, controlling only the output voltage, or controlling only the output current is conceivable. Also, when the control of the output voltage/output current setting value control unit 109 is realized by a microcomputer, it is conceivable to perform PWM control of the switch 105 using the microcomputer for output voltage/output current setting value control.

[0049] Next, a second embodiment of the AC adapter 11 will be described with reference to Figure 3. The second embodiment shown in Figure 3 shows a configuration example in which recognition of the specifications by impedance variation is realized by detecting voltage variation.

[0050] The AC adapter 11 according to the second embodiment differs significantly from the AC adapter 11 according to the first embodiment described above in the following two points.

(1) The data input to the comparator 117 is voltage data (ed) instead of current data (id).

[0051] (2) A diode 119 for preventing unnecessary current circulation of the current comparison data (ic) input to the comparator 117 is added. Accompanying these changes (1) and (2),

(a) the current data (id) is input to the current error amplifier 112 and the timer 110 (not input to the comparator 117 here).

[0052] (b) The voltage data (ed) is input to the voltage error amplifier 115 and the comparator 117.

(c) The comparator 117 compares the reference voltage (e3) of the reference voltage setting unit 118 with the voltage data (ed), and when the reference voltage (e3) of the reference voltage setting unit 118 is less than or equal to the voltage data (ed), it sends "1" to the output voltage/output current setting value control unit 109. When the reference voltage (e3) of the reference voltage setting unit 118 is greater than the voltage data (ed), it sends "0" to the output voltage/output current setting value control unit 109.

[0053] The output voltage/output current setting value control unit 109 detects the output impedance variation by the electronic device main body 12 from this "1" and "0," and switches the reference voltage value (e1) of the reference voltage setting unit 116 and the reference voltage values of the current limit value (1) and the current limit value (2) switched by the timer 110 according to the variation content.

[0054] Other operations are the same as the operation of the AC adapter 11 in the first embodiment described with reference to Figure 2. Next, the main configuration of the electronic device main body 12 according to the embodiment of the present invention will be described with reference to Figure 4.

[0055] When the AC adapter 11 is connected to the electronic device main body 12, the input impedance control unit 19 switches the switch S11 of the impedance switching unit 17 on/off according to the impedance variation means predetermined by the input specifications of the electronic device main body 12, thereby varying the impedance on the power output line (PL) of the AC adapter 11. After the end of this output impedance variation, power according to the device specifications is supplied from the AC adapter 11 to the system 18 as the operating power source.

[0056] At this time, the resistor R11 of the impedance switching unit 17 is provided to protect the switch S11 and to determine the variation range of the input impedance. Next, an embodiment of the present invention in which the electronic device main body 12 is provided with a secondary battery will be described with reference to Figure 5.

[0057] When the AC adapter 11 is connected to the electronic device main body 12, the input impedance control unit 18 switches the switch of the impedance switching unit 17 by impedance variation means predetermined by the power input specifications of the system 19, thereby varying the impedance on the power output line (PL) of the AC adapter 11.

[0058] When the secondary battery 21 is charged with a constant current during power-off or sleep state of the system 19, the charging control unit 22 reads the maximum charging current and maximum charging voltage data from the storage unit provided in the secondary battery 21 and sends this to the input impedance control unit 18.

[0059] The input impedance control unit 18 determines the power input specifications of the electronic device main body 12 based on the maximum charging current and maximum charging voltage data, and according to the power input specifications, switches the switch of the impedance switching unit 17 by a predetermined variation means to vary the impedance on the power output line (PL) of the AC adapter 11.

[0060] This output impedance variation determines the constant current value for constant current charging of the secondary battery 21. The diode D11 is provided to prevent unnecessary current circulation from the secondary battery 21 to the switch of the impedance switching unit 17 when the secondary battery 21 is connected, and to allow the output impedance to vary by the switch of the impedance switching unit 17. Various switching elements such as switching transistors and FETs can be applied to the switch of the input impedance switching unit 17.

[0061] As a modification example of the charging control of the above secondary battery, when the secondary battery 21 is charged with a constant current during power-off of the system 19, the charging control unit 22 first reads the current battery capacity, maximum charging current, and maximum charging voltage from the battery capacity data stored in the storage unit of the secondary battery 21, and sends these values to the input impedance control unit 18. When charging starts, the charging capacity is recognized by the charging current, and the battery capacity data stored in the storage unit of the secondary battery 21 is rewritten according to the recognized value.

[0062] During charging of the above secondary battery 21, the input impedance control unit 18 switches the switch of the impedance switching unit 17 on/off by impedance variation means predetermined according to the power input specifications determined by the maximum charging current and maximum charging voltage input from the charging control unit 22, thereby varying the impedance on the power output line (PL) of the AC adapter 11. This output impedance variation determines the constant current value for constant current charging of the secondary battery 21.

[0063] Next, specific examples of notifying the power input specifications of the device to the AC adapter 11 by impedance variation on the power output line (PL), and specific examples of recognizing the power input specifications of the device by the AC adapter 11 based on the above impedance variation and switching the output specifications will be described with reference to Figures 6 to 12.

[0064] Here, as the means for notifying the power input specifications of the device by impedance variation and the means for recognizing the power input specifications of the device on the AC adapter 11 side, three examples are given, the case of digital data, the case of period data, and the case of duty data accompanying impedance variation by the above switch operation, and specifications 1 to 4 are recognized and switched as targets.

[0065] When the input impedance control unit 19 of the electronic device main body 12 recognizes that power for information exchange at a predetermined low voltage is supplied on the power output line (PL), the input impedance switching unit 17 is switched (on/off) controlled according to the power input specifications of the device itself by a predetermined identification information type (digital data/period data/duty data) for a certain period, thereby varying the impedance on the power output line (PL). Here, data (specification number data) indicating the device input specifications in a digital data format as shown in Figure 10, a period data format as shown in Figure 11, or a duty data format as shown in Figure 12 is announced to the AC adapter 11 via the power output line (PL).

[0066] The output voltage/output current detection unit 14 of the AC adapter 11 detects the above output impedance variation and sends it to the output variation analysis unit 15. The output variation analysis unit 15 analyzes the content of the output impedance variation as shown in Figures 10, 11, or 12. Based on the analysis result of this variation content, the output voltage/output current setting value control unit 16 switches the set values of the output voltage and output current of the AC adapter 11 according to the power input specifications of the connected electronic device main body 12.

[0067] Here, when the output voltage/output current setting value control unit 16 receives data indicating the device input specifications in a digital data format as shown in Figure 10, the output specification setting process as shown in Figure 6 is executed; when data indicating the device input specifications in a period data format as shown in Figure 11 is received, the output specification setting process as shown in Figure 7

is executed; and when data indicating the device input specifications in a duty data format as shown in Figure 12 is received, the output specification setting process as shown in Figure 8 is executed.

[0068] In the output specification setting process shown in Figure 6, when the output voltage/output current setting value control unit 16 receives device input specification data in a digital data format as shown in Figure 10 (steps S11, S12 in Figure 6), the data content is determined (steps S13, S15, S17, S19 in Figure 6), and if the data content is "1h," the output specification "Specification 1" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S14 in Figure 6); if the data content is "2h," the output specification "Specification 2" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S16 in Figure 6); if the data content is "3h," the output specification "Specification 3" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S18 in Figure 6); and if the data content is "4h," the output specification "Specification 4" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S20 in Figure 6).

[0069] In the output specification setting process shown in Figure 7, when the output voltage/output current setting value control unit 16 receives device input specification data in a period data format as shown in Figure 11 (steps S21, S22 in Figure 7), the data content is determined (steps S23, S25, S27, S29 in Figure 7), and if the data content is "20 ms period," the output specification "Specification 1" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S24 in Figure 7); if the data content is "10 ms period," the output specification "Specification 2" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S26 in Figure 7); if the data content is "5 ms period," the output specification "Specification 3" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S28 in Figure 7); and if the data content is "2.5 ms period," the output specification "Specification 4" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S30 in Figure 7).

[0070] In the output specification setting process shown in Figure 8, when the output voltage/output current setting value control unit 16 receives device input specification data in a duty data format as shown in Figure 12 (steps S31, S32 in Figure 8), the data content is determined (steps S33, S35, S37, S39 in Figure 8), and if the data content is "duty 20%," the output specification "Specification 1" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S34 in Figure 8); if the data content is "duty 40%," the output specification "Specification 2" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S36 in Figure 8); if the data content is "duty 60%," the output specification "Specification 3" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S38 in Figure 8); and if the data content is "duty 80%," the output specification "Specification 4" shown in Figure 9 is set and power according to the specification is output on the power output line (PL) (step S40 in Figure 8).

[0071] As described above, the input impedance control unit 19 of the electronic device main body 12 switches the switch of the impedance switching unit 17 by switching control according to the power input specifications of the device itself, and notifies the AC adapter 11 of the specification identification information corresponding to the device specifications among the four types of specifications (Specification 1 to Specification 4) shown in Figure 9 by impedance variation on the power output line (PL) in a digital data format as shown in Figure 10, a period data format as shown in Figure 11, or a duty data

format as shown in Figure 12. The output voltage/output current setting value control unit 16 of the AC adapter 11 recognizes the power input specifications of the electronic device main body 12 received from the output variation analysis unit 15 by the processing procedures shown in Figures 6, 7, or 8, sets the output specifications, and outputs power according to the specifications on the power output line (PL).

[0072] When the output specifications of the AC adapter 11 do not match the input specifications of the electronic device main body 12, the AC adapter 11 maintains a certain low power low voltage output state or stops power supply at the time of connection, thereby avoiding inconvenience caused by supplying an abnormal operating power source to the electronic device main body 12. Also, when there is no impedance variation for notifying the device specifications or for identifying the AC adapter 11, device protection such as maintaining the low power low voltage output state or stopping power supply at the time of connection is performed similarly.

[0073] According to the embodiment of the present invention described above, in an electronic device receiving power according to specifications from an AC adapter and an AC adapter provided with an output specification switching function, a function of supplying power matching the specifications of the electronic device by a two-wire system using only the power output line (PL) without using any extra signal lines can be realized by means for varying the impedance of the adapter power input line of the electronic device for a certain period.

[0074] Also, since the output specifications of the AC adapter can be varied according to the power input specifications of the electronic device, there is no need to prepare a dedicated AC adapter for each electronic device, and the same AC adapter can be used for electronic devices having different power input specifications.

[0075] Also, since the impedance variation time of the external power input line of the electronic device is limited and the operating power source is not supplied to the device until the device specifications are recognized and set, the influence of noise on the device can be reliably prevented.

[0076] Also, when the output specifications of the AC adapter do not match the power input specifications of the electronic device or when there is no impedance variation on the electronic device side for identifying the AC adapter (or notifying the device specifications to the AC adapter), device protection measures such as stopping output, lowering voltage, or preventing large current flow can be easily taken.

[0077] In the above embodiment, there are four types of power input specifications for the device, and the input specifications of the device are recognized and the output specifications are switched by identification information based on combinations of "1" and "0" (digital data), or identification information in which the frequencies (periods) of "1" and "0" are different (period data), or identification information in which the duty cycles of "1" and "0" are different (duty data), but the present invention is not limited thereto. For example, in the device specification recognition mode, the device side may maintain the power output line (PL) in an impedance state unique to the device specifications, such as pulling down to a potential state of 3 V for device A of Specification 1, or pulling down to a potential state of 1.5 V for device B of Specification 2, as impedance variation means.

[0078] Also, the configuration of the AC adapter 11 is not limited to the circuit configurations shown in Figures 2 and 3, and the present invention can be applied to configurations in which only one of voltage detection or current detection is provided, or configurations for charging batteries other than secondary batteries by constant current constant voltage charging.

[0079] [Effect of the Invention] As described in detail above, according to the present invention, in an electronic device operable by an AC adapter power source, an electronic device and an AC adapter capable of supplying and controlling a stable operating power source always according to the device specifications to multiple types of devices having different power input specifications without preparing an AC adapter unique to each device can be provided.

[0080] Furthermore, according to the present invention, in an electronic device operable by an AC adapter power source, by connecting an AC adapter to the device main body, an electronic device and an AC adapter capable of realizing an automatic recognition function of device specifications and a matching function of output power source, in which the AC adapter generates and outputs an operating power source according to the specifications of the device main body, without requiring a dedicated control signal line, and without causing noise influence on device operation, can be provided.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Figure 1 is a block diagram showing a main configuration of the entire electronic device including the AC adapter according to the embodiment of the present invention.

Figure 2 is a block diagram showing a circuit configuration of the AC adapter according to the first embodiment of the present invention.

Figure 3 is a block diagram showing a circuit configuration of the AC adapter according to the second embodiment of the present invention.

Figure 4 is a diagram showing a configuration of an impedance switching control circuit of the electronic device main body according to the embodiment of the present invention.

Figure 5 is a diagram showing a configuration of an impedance switching control circuit including a charging control circuit of a secondary battery of the electronic device main body according to the embodiment of the present invention.

Figure 6 is a flowchart showing an output specification setting procedure when the AC adapter receives data indicating device input specifications in a digital data format according to the embodiment of the present invention.

Figure 7 is a flowchart showing an output specification setting procedure when the AC adapter receives data indicating device input specifications in a frequency (period) data format according to the embodiment of the present invention.

Figure 8 is a flowchart showing an output specification setting procedure when the AC adapter receives data indicating device input specifications in a duty data format according to the embodiment of the present invention.

Figure 9 is a diagram showing examples of device specifications for explaining the operation in the above embodiment.

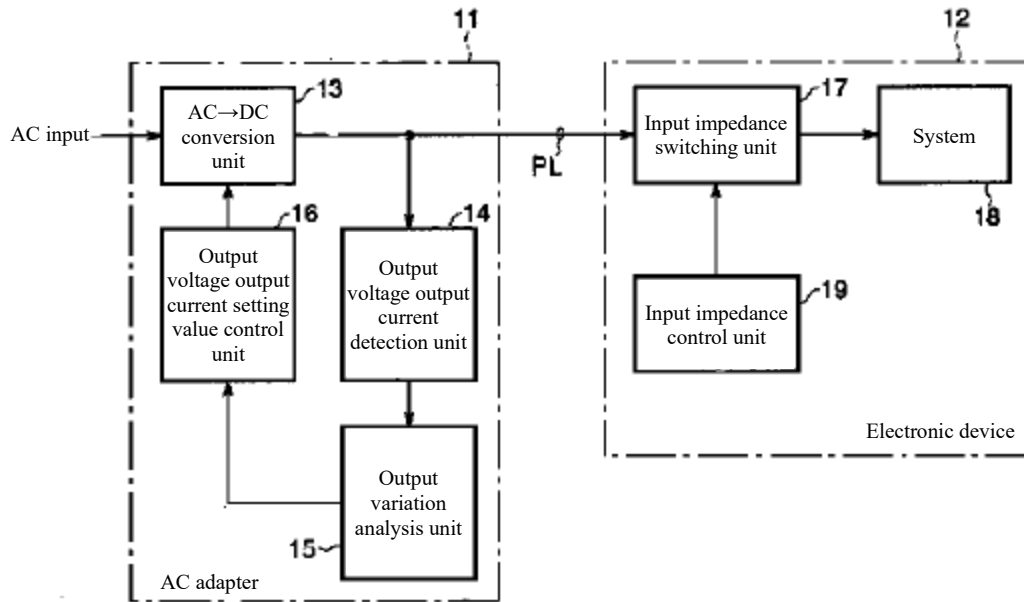
Figure 10 is a timing chart when impedance variation according to the device specifications shown in Figure 9 is performed by data in the above embodiment.

Figure 11 is a timing chart when impedance variation according to the device specifications shown in Figure 9 is performed by frequency (period) in the above embodiment.

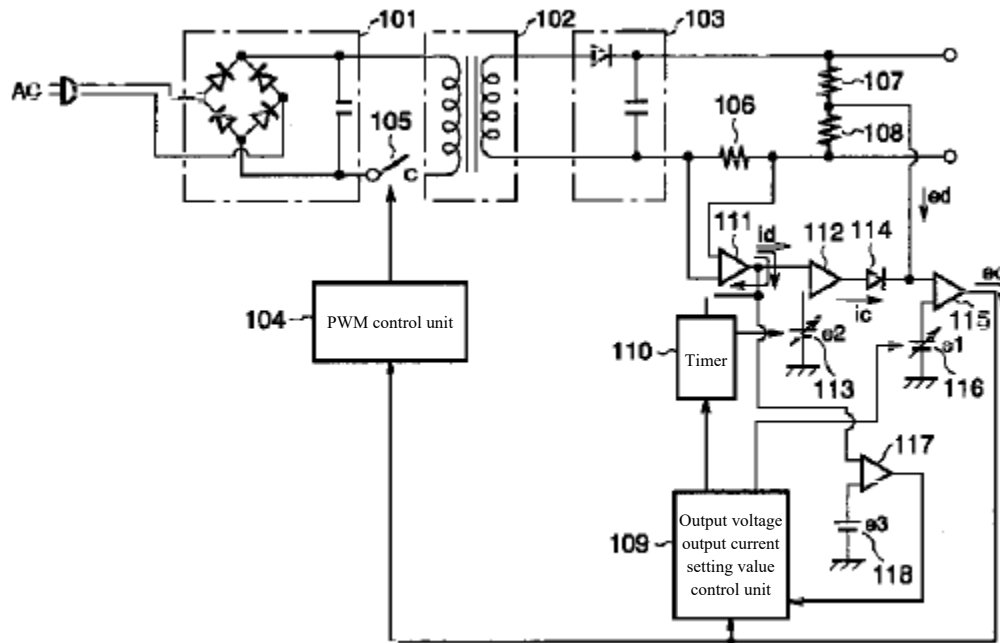
Figure 12 is a timing chart when impedance variation according to the device specifications shown in Figure 9 is performed by duty in the above embodiment.

[Explanation of Reference Numerals]

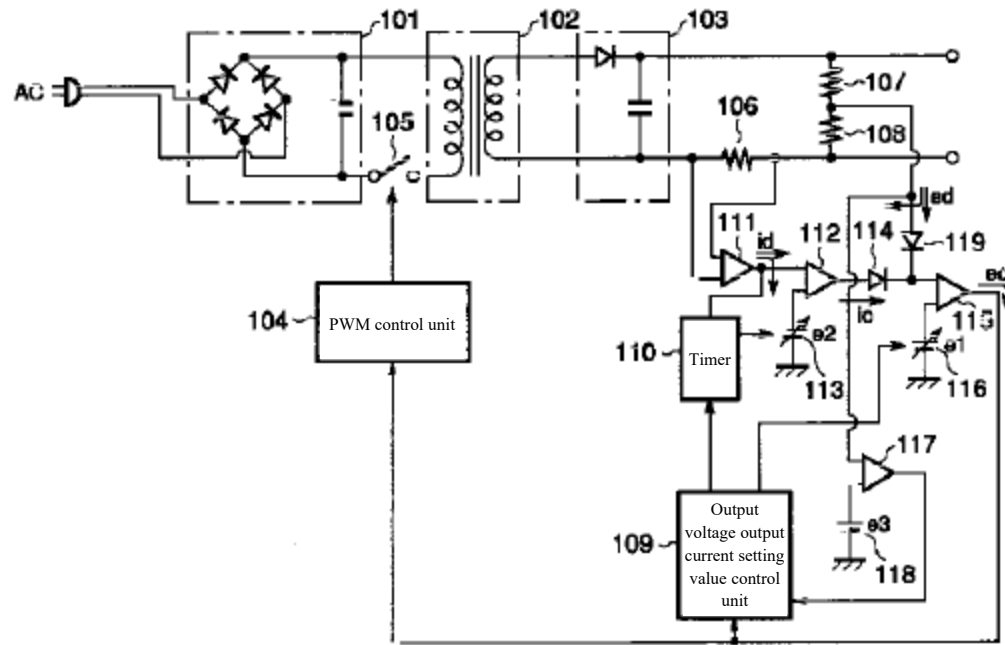
- 11...AC adapter,
- 12...Electronic device main body,
- 13...AC→DC conversion unit,
- 14...Output voltage/output current detection unit,
- 15...Output variation analysis unit,
- 16...Output voltage/output current setting value control unit,
- 17...Input impedance switching unit,
- 18...Main circuit unit (system),
- 19...Input impedance control unit,
- 21...Secondary battery,
- 22...Charging control unit,
- 101...Front-stage rectifier circuit,
- 102...Transformer,
- 103...Rear-stage rectifier circuit,
- 104...PWM control unit,
- 105...Switching circuit,
- 106...Current detection resistor,
- 107...Voltage dividing resistor,
- 108...Voltage dividing resistor,
- 109...Output voltage/output current setting value control unit,
- 110...Timer,
- 111...Amplifier,
- 112...Current error amplifier,
- 113...Reference voltage setting unit,
- 114...Diode,
- 115...Voltage error amplifier,
- 116...Reference voltage setting unit,
- 117...Comparator,
- 118...Reference voltage setting unit,
- 119...Diode,
- PL...Power output line of the AC adapter 11.



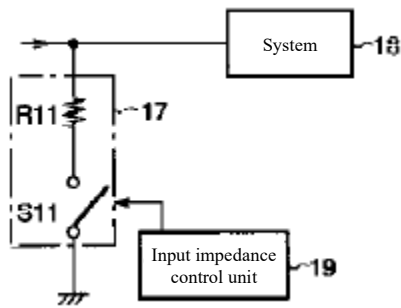
[FIGURE 1]



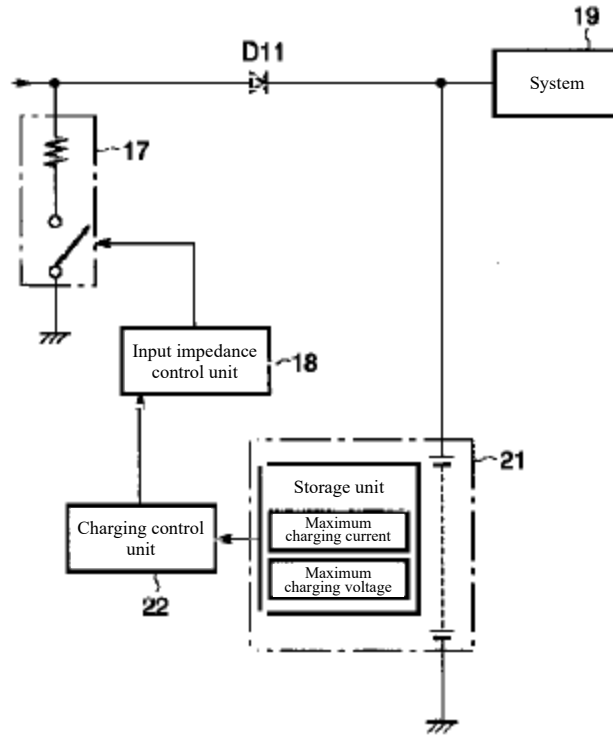
[FIGURE 2]



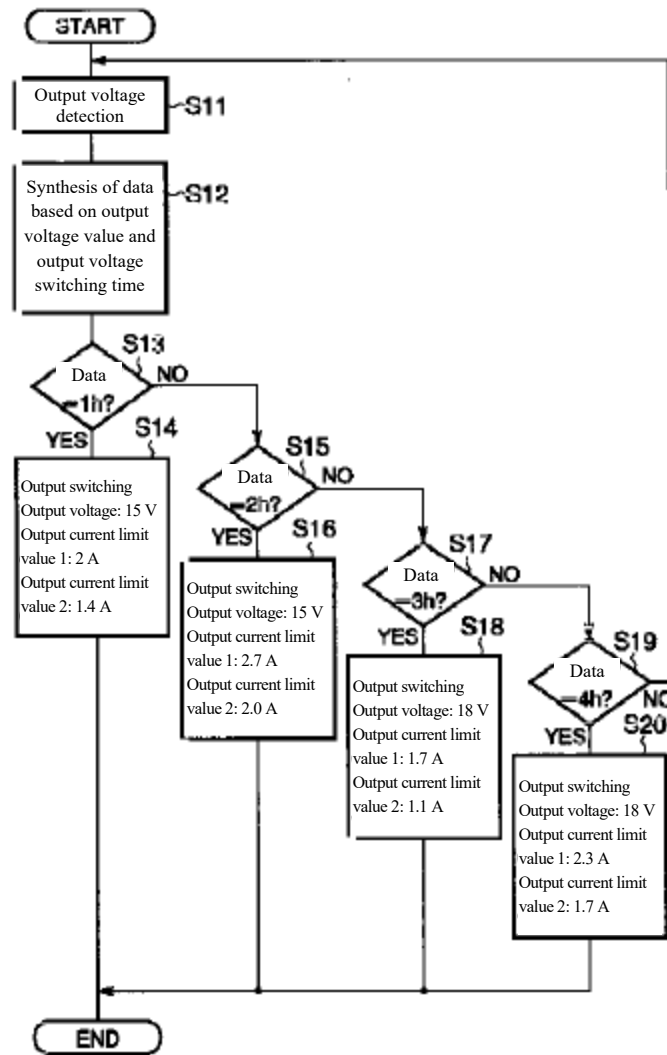
[FIGURE 3]



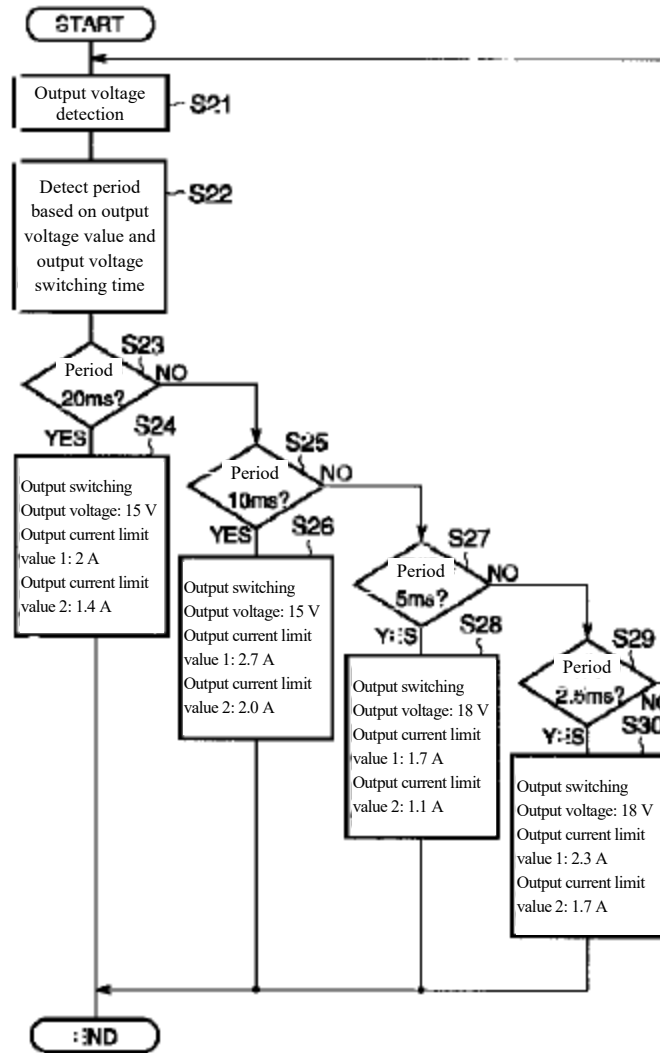
[FIGURE 4]



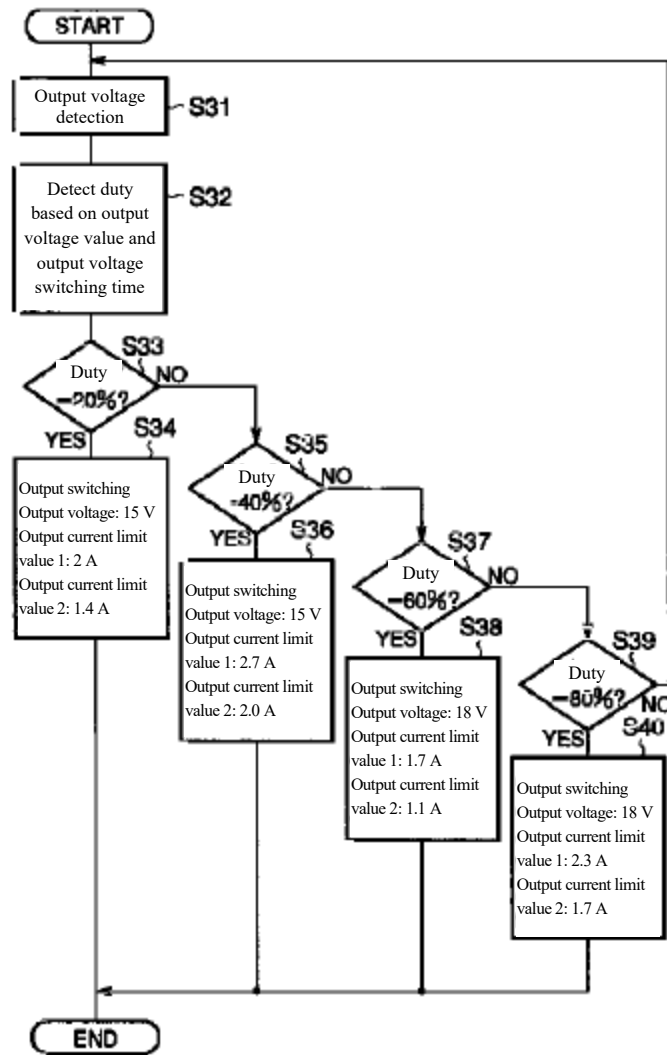
[FIGURE 5]



[FIGURE 6]



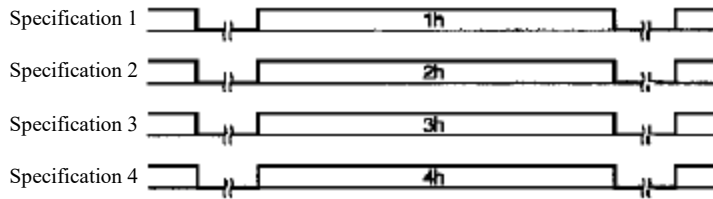
[FIGURE 7]



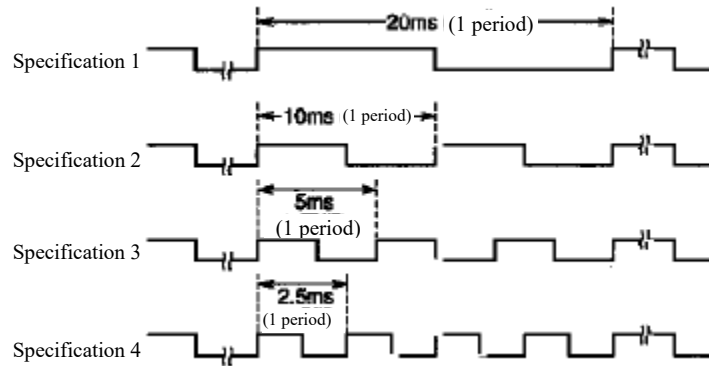
[FIGURE 8]

Specification No.	Output voltage [V]	Output current limit value 1 [A]	Output current limit value 2 [A]
Specification 1	15	2.0	1.4
Specification 2	15	2.7	2.0
Specification 3	18	1.7	1.1
Specification 4	18	2.3	1.7

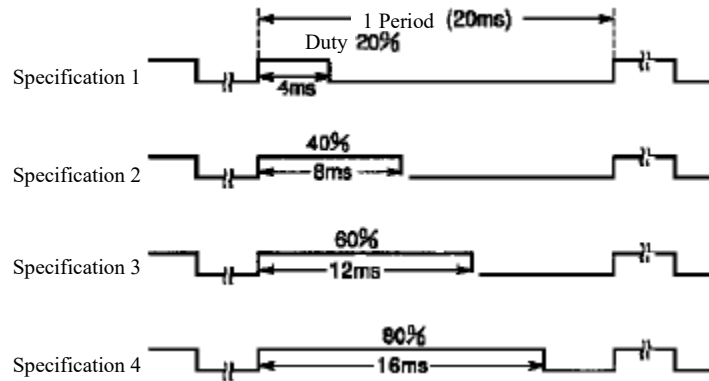
[FIGURE 9]



[FIGURE 10]



[FIGURE 11]



[FIGURE 12]



August 21, 2025

Re: JP_2000134816_A_-_Tanaka

To Whom It May Concern:

This is to certify that the above-referenced document (**390-46345_JP_2000134816_A_-_Tanaka_JA into EN**) has been translated from Japanese into English by a professional translator on our staff who is skilled in the Japanese language.

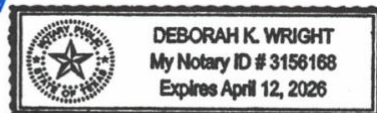
The English translation conforms essentially to the original Japanese except for those words or phrases for which there are no equivalents. Such words or phrases are noted in the translation along with the best English meaning.

All statements made in this declaration of our own knowledge are true, and all statements made on information and belief are believed to be true. We certify these statements under the understanding that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001). To the best of our knowledge, the aforementioned documents are a true, full, and accurate translation into English of the specified document.

Tonja Shepard
TONJA SHEPARD

Subscribed and sworn to before me on August 21, 2025.

Deborah K. Wright
Deborah K. Wright
Notary Public, State of Texas



My commission expires on April 12, 2026