ELECTRONIC DEVICE AND POWER ADAPTER THEREFOR

TECHNICAL FIELD

[0001] The present disclosure generally relates to the charging technical field, and more particularly, to an electronic device and a power adapter therefor.

BACKGROUND

[0002] Currently, most electronic devices charge a battery by acquiring direct current from a power adapter through a communication interface thereof. However, in the related art, in order to reduce charging time during charging the battery, the charging current may be enhanced by the power adapter to realize an aim of performing a quick charging on the battery. However, when charging the battery either in a conventional constant voltage mode or with increased charging current, if a charging current and/or charging voltage of the battery is too high during the charging, the battery will be damaged due to overvoltage and/or overcurrent charging. Therefore, in the related art, an overcurrent protection and/or an overvoltage protection cannot be realized for the battery when the power adapter performs a conventional charging or quick charging on the battery in the electronic device.

SUMMARY

[0003] An objective of the present disclosure is to provide a power adapter, so as to solve a problem in the related art that an overcurrent protection and/or an overvoltage protection cannot be realized for a battery when the power adapter performs a conventional charging or quick charging on the battery in the electronic device.

[0004] The present disclosure is realized as follows. There is provided a power adapter, including a communication interface through which the power adapter charges a battery in an electronic device and performs a data communication with the electronic device. The power adapter includes an EMI filter circuit, a high-voltage rectifying and filtering circuit, an isolation transformer, an output filtering circuit, and a voltage tracking and controlling circuit;

[0005] The power adapter further includes a power module, a main control module, a potential adjusting module, a current detection module, a voltage detection module and an output switch module.

[0006] An input end of the power module is connected with a secondary end of the isolation transformer; a power end of the main control module, a power end of the potential adjusting module and a power end of the current detection module are collectively connected with

an output end of the power module; both a high-level end of the main control module and a high-level end of the potential adjusting module are connected with a positive output end of the output filtering circuit; a potential adjusting end of the potential adjusting module is connected with the voltage tracking and controlling circuit; a direct current input end of the current detection module is connected with the positive output end of the output filtering circuit; a current feedback end of the current detection module is connected with a current detecting end of the main control module; a clock output end of the main control module is connected with a clock output end of the potential adjusting module; a data output end of the main control module is connected with a data input end of the potential adjusting module; a first detecting end and a second detecting end of the voltage detection module are connected with a direct current output end of the current detection module and a negative output end of the output filtering circuit respectively; a first output end and a second output end of the voltage detection module are connected with a first voltage detecting end and a second voltage detecting end of the main control module respectively; an input end of the output switch module is connected with the direct current output end of the current detection module; an output end of the output switch module and the negative output end of the output filtering circuit are connected with the communication interface; and the output end of the output switch module is connected with a third detecting end of the voltage detection module; a ground end of the output switch module is connected with the negative output end of the output filtering circuit; a controlled end of the output switch module is connected with a switching control end of the main control module; a power end of the output switch module is connected with the secondary end of the isolation transformer; each of the negative output end of the output filtering circuit, the output end of the output switch module and a first communication end and a second communication end of the main control module is connected with the communication interface.

[0007] The power module obtains power supply from the isolation transformer and provides the power supply for the main control module, the potential adjusting module and the current detection module; the potential adjusting module drives the voltage tracking and controlling circuit to adjust an output voltage of the isolation transformer according to a control signal sent by the main control module; the current detection module detects an output current of the power adapter and feeds back a current detecting signal to the main control module, and the voltage detection module detects an output voltage of the power adapter and feeds back a voltage detecting signal to the main control module; the output switch module turns on or off a direct current output of the power adapter according to a switching control signal sent by the main control module.

[0008] When a conventional charging or a quick charging is performed on the battery in

the electronic device, the main control module determines whether the output current of the power adapter is greater than a current threshold according to the current detecting signal and determines whether the output voltage of the power adapter is greater than a voltage threshold according to the voltage detecting signal; if the output current of the power adapter is greater than the current threshold and/or the output voltage of the power adapter is greater than the voltage threshold, the main control module controls the output switch module to turn off the direct current output of the power adapter.

[0009] During the data communication between the main control module and the electronic device, if the electronic device determines that the output current of the power adapter is greater than the current threshold and/or the output voltage of the power adapter is greater than the voltage threshold, and feeds back a charging stop instruction to the main control module, the main control module controls the output switch module to turn off the direct current output of the power adapter according to the charging stop instruction.

[0010] Another objective of the present disclosure is to provide an electronic device, including a battery and further provided with the power adapter described above.

[0011] In the present disclosure, the power adapter including the power module, the main control module, the potential adjusting module, the current detection module, the voltage detection module and the output switch module is provided for the electronic device. The main control module determines whether the output current of the power adapter is greater than the current threshold, and determines whether the output voltage of the power adapter is greater than the voltage threshold. If the output current is greater than the current threshold and/or the output voltage is greater than the voltage threshold, the main control module controls the output switch module to turn off the direct current output of the power adapter. In addition, if the electronic device determines that an overcurrent and/or overvoltage occurs in the output of the power adapter, and feeds back the charging stop instruction to the main control module, the main control module controls the output switch module to turn off the direct current output of the power adapter according to the charging stop instruction, such that the overcurrent and/or overvoltage protection is realized for the battery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Fig. 1 is a block diagram of a power adapter provided by an embodiment of the present disclosure.

[0013] Fig. 2 is a schematic circuit diagram of a power adapter provided by an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0014] To make objectives, technical solutions, and advantages of embodiments of the present invention clearer, the technical solutions in embodiments of the present invention are hereinafter described clearly and completely with reference to the accompanying drawings in embodiments of the present invention. It should be understood that, the specific embodiments described herein are merely used for explanation, but not used to limit the present disclosure.

[0015] Fig. 1 is a block diagram of a power adapter provided by an embodiment of the present disclosure. For illustration purposes, only parts related to embodiments of the present disclosure are shown, which will be described in detail in the following.

[0016] The power adapter 100 provided by an embodiment of the present disclosure includes a communication interface 10, the power adapter 100 charges a battery 201 in an electronic device 200 and performs a data communication with the electronic device 200 through the communication interface 10.

[0017] The power adapter 100 includes an EMI filtering circuit 101, a high-voltage rectifying and filtering circuit 102, an isolation transformer 103, an output filtering circuit 104 and a voltage tracking and controlling circuit 105. After an electromagnetic interference filtering is performed on the electric supply by the EMI filtering circuit 101, the high-voltage rectifying and filtering circuit 102 performs a rectifying and filtering process and outputs a high-voltage direct current, which is outputted to the output filtering circuit 104 after the electrical isolation in the isolation transformer 103, for being filtered and used to charge the battery 201. The voltage tracking and controlling circuit 105 adjusts an output voltage of the isolation transformer 103 according to an output voltage of the output filtering circuit 104.

[0018] The power adapter 100 further includes: a power module 106, a main control module 107, a potential adjusting module 108, a current detection module 109, a voltage detection module 110 and an output switch module 111.

[0019] An input end of the power module 106 is connected with a secondary end of the isolation transformer 103. A power end of the main control module 107, a power end of the potential adjusting module 108 and a power end of the current detection module 109 are collectively connected with an output end of the power module 106. Both a high-level end of the main control module 107 and a high-level end of the potential adjusting module 108 are connected with a positive output end of the output filtering circuit 104. A potential adjusting end of the potential adjusting module 108 is connected with the voltage tracking and controlling circuit 105. A direct current input end of the current detection module 109 is connected with the positive

output end of the output filtering circuit 104. A current feedback end of the current detection module 109 is connected with a current detecting end of the main control module 107. A clock output end of the main control module 107 is connected with a clock input end of the potential adjusting module 108. A data output end of the main control module 107 is connected with a data input end of the potential adjusting module 108. A first detecting end and a second detecting end of the voltage detection module 110 are connected with a direct current output end of the current detection module 109 and a negative output end of the output filtering circuit 104 respectively. A first output end and a second output end of the voltage detection module 110 are connected with a first voltage detecting end and a second voltage detecting end of the main control module 107 respectively. An input end of the output switch module 111 is connected with the direct current output end of the current detection module 109; and an output end of the output switch module 111 is connected with a third detecting end of the voltage detection module 110. A ground end of the output switch module 111 is connected with the negative output end of the output filtering circuit 104. A controlled end of the output switch module 111 is connected with a switching control end of the main control module 107. A power end of the output switch module 111 is connected with the secondary end of the isolation transformer 103. Each of the negative output end of the output filtering circuit 104, the output end of the output switch module 111 and a first communication end and a second communication end of the main control module 107 is connected with the communication interface 10 of the power adapter 100.

[0020] The power module 106 obtains power supply from the isolation transformer 103 and provides the power supply for the main control module 107, the potential adjusting module 108 and the current detection module 109; when a quick charging is performed on the battery 201 in the electronic device 200, the potential adjusting module 108 drives the voltage tracking and controlling circuit 105 to adjust an output voltage of the isolation transformer 103 according to a control signal sent by the main control module 107; the current detection module 109 detects an output current of the power adapter 100 and feeds back a current detecting signal to the main control module 107, and the voltage detection module 110 detects an output voltage of the power adapter 100 and feeds back a voltage detecting signal to the main control module 107; the output switch module 111 turns on or off a direct current output of the power adapter 100 according to a switching control signal sent by the main control module 107.

[0021] When a conventional charging or a quick charging is performed on the battery 201 in the electronic device 200, the main control module 107 determines whether the output current of the power adapter 100 is greater than a current threshold according to the current detecting signal, and determines whether the output voltage of the power adapter 100 is greater than a voltage

threshold according to the voltage detecting signal; if the output current of the power adapter 100 is greater than the current threshold and/or the output voltage of the power adapter 100 is greater than the voltage threshold, the main control module 107 controls the output switch module 111 to turn off the direct current output of the power adapter 100.

[0022] During the data communication between the main control module 107 and the electronic device 200, if the electronic device 200 determines that the output current of the power adapter 100 is greater than the current threshold and/or the output voltage of the power adapter 100 is greater than the voltage threshold, and feeds back a charging stop instruction to the main control module 107, the main control module 107 controls the output switch module 111 to turn off the direct current output of the power adapter 100 according to the charging stop instruction.

[0023] It should be noted that, the data communication between the main control module 107 and the electronic device 200 is performed during the charging. During this process, either in the conventional charging mode or in the quick charging mode, the main control module 107 would send the output current and output voltage of the power adapter 100 to the electronic device 200. The electronic device 200 determines according to the output current and output voltage of the power adapter 100 whether an overcurrent and/or overvoltage occur during the charging. The determine process is the same as the process in which the main control module 107 determines the output current and output voltage of the power adapter 100, such that the electronic device 200 may feedback a charging stop instruction for informing the main control module 107 of turning off the direct current output of the power adapter 100 when the electronic device 200 determines that an overcurrent and/or overvoltage occurs in the output of the power adapter 100. Moreover, the electronic device 200 may close its communication interface actively when determining that an overcurrent and/or overvoltage occurs in the output of the power adapter 100, so as to disconnect from the power adapter 100, such that the overcurrent and/or overvoltage protection may be realized actively.

[0024] Fig. 2 is a schematic circuit diagram of a power adapter provided by an embodiment of the present disclosure. For illustration purposes, only parts related to embodiments of the present disclosure are shown, which will be described in detail in the following.

[0025] The power module 106 includes: a first capacitor C1, a voltage stabilizing chip U1, a second capacitor C2, a first inductor L1, a second inductor L2, a fist diode D1, a second diode D2, a third capacitor C3, a first resistor R1 and a second resistor R2.

[0026] A collective node of a first end of the first capacitor C1, an input power pin Vin and an enable pin EN of the voltage stabilizing chip U1 is configured as the input end of the power module 106. A second end of the first capacitor C1 and a ground pin GND of the voltage

stabilizing chip U1 are collectively grounded. A switch pin SW of the voltage stabilizing chip U1 and a first end of the second capacitor C2 are collectively connected with a first end of the first inductor L1. An inside switch pin BOOST of the voltage stabilizing chip U1 and a second end of the second capacitor C2 are collectively connected with a cathode of the first diode D1. A feedback voltage pin FB of the voltage stabilizing chip U1 is connected with a first end of the first resistor R1 and a first end of the second resistor R2 respectively. A second end of the first inductor L1 and a cathode of the second diode D2 are collectively connected with a first end of the second inductor. A collective node formed by collectively connecting a second end of the second inductor L2, an anode of the first diode D1, a second end of the first resistor R1 and a first end of the third capacitor C3 is configured as the output end of the power module 106. An anode of the second diode D2, a second end of the second resistor R2 and a second end of the third capacitor C3 are collectively grounded. After using the voltage stabilizing chip U1 as a core to perform a voltage converting process on a voltage at the secondary end of the isolation transformer 103, the power module 106 outputs the voltage of +3.3V for providing power supply for the main control module 107, the potential adjusting module 108 and the current detection module 109. The voltage stabilizing chip U1 may be a buck DC/DC converter with a Model No. MCP16301.

[0027] The main control module 107 includes: a main control chip U2, a third resistor R3, a reference voltage chip U3, a fourth resistor R4, a fifth resistor R5, a fourth capacitor C4, a sixth resistor R6, a seventh resistor R7, a first NMOS transistor Q1, an eighth resistor R8, a ninth resistor R9, a tenth resistor R10, an eleventh resistor R11, a twelfth resistor R12, a thirteenth resistor R13 and a fourteenth resistor R14.

[0028] A power pin VDD of the main control chip U3 is configured as the power end of the main control module 107. A ground pin VSS of the main control chip U3 is grounded. A first input/output pin RA0 of the main control chip U3 is suspended. A first end of the third resistor R3 is connected with the power pin VDD of the main control chip U3. A second end of the third resistor R3 and a first end of the fourth resistor R4 are collectively connected with a cathode CATHODE of the reference voltage chip U3. An anode ANODE of the reference voltage chip U3 is grounded. A vacant pin NC of the reference voltage chip U3 is suspended. A second end of the fourth resistor R4 is connected with a second input/output pin RA1 of the main control chip U2. A third input/output pin RA2 of the main control chip U2 is configured as the current detecting end of the main control module 107. A fourth input/output pin RA3 of the main control chip U2 is connected with a first end of the fifth resistor R5. A second end of the fifth resistor R5 and a first end of the fourth capacitor C4 are collectively connected with the power pin VDD of the main control chip U2. A second end of the fourth capacitor C4 is grounded. A fifth input/output pin

RA4 of the main control chip U2 is configured as the switching control end of the main control module 107. A sixth input/output pin RA5 of the main control chip U2 is connected with a first end of the sixth resistor R6. A second end of the sixth resistor R6 and a grid electrode of the first NMOS transistor Q1 are collectively connected with a first end of the seventh resistor R7. A second end of the seventh resistor R7 and a source electrode of the first NMOS transistor Q1 are collectively grounded. A drain electrode of the first NMOS transistor Q1 is connected with a first end of the eighth resistor R8. A second end of the eighth resistor R8 is configured as the high-level end of the main control module 107. A seventh input/output pin RC0 and an eighth input/output pin RC1 of the main control chip U2 are configured as the clock output end and the data output end of the main control module 107 respectively. A ninth input/output pin RC2 and a tenth input/output pin RC3 of the main control chip U2 are configured as the first voltage detecting end and the second voltage detecting end of the main control module 107 respectively. An eleventh input/output pin RC4 and a twelfth input/output pin RC5 of the main control chip U2 are connected with a first end of the ninth resistor R9 and a first end of the tenth resistor R10 respectively. A first end of the eleventh resistor R11 and a first end of the twelfth resistor R12 are connected with a second end of the ninth resistor R9 and a second end of the tenth resistor R10 respectively. A second end of the eleventh resistor R11 and a second end of the twelfth resistor R12 are collectively grounded. A first end of the thirteenth resistor R13 and a first end of the fourteenth resistor R14 are connected with the second end of the ninth resistor R9 and the second end of the tenth resistor R10 respectively. A second end of the thirteenth resistor R13 and a second end of the fourteenth resistor R14 are collectively connected with the power pin VDD of the main control chip U2. The second end of the ninth resistor R9 and the second end of the tenth resistor R10 are configured as the first communication end and the second communication end of the main control module 107 respectively. The main control chip U2 may be a single chip microcomputer with a Model No. PIC12LF1822, PIC12F1822, PIC16LF1823 or PIC16F1823, and the reference voltage chip U3 may be a voltage reference device with a Model No. LM4040.

[0029] The potential adjusting module 108 includes: a fifteenth resistor R15, a sixteenth resistor R16, a digital potentiometer U4, a seventeenth resistor R17, an eighteenth resistor R18, a fifth capacitor C5, a sixth capacitor C6 and a nineteenth resistor R19.

[0030] A collective node of a first end of the fifteenth resistor R15, a first end of the sixteenth resistor R16, a power pin VDD of the digital potentiometer U4 and a first end of the fifth capacitor C5 is configured as the power end of the potential adjusting module 108. A second end of the fifth capacitor C5, a first end of the sixth capacitor C6, a ground pin VSS of the digital potentiometer U4 and a first end of the seventeenth resistor R17 are collectively grounded. A

second end of the sixth capacitor C6 is connected with the power pin VDD of the digital potentiometer U4. A collective node between a second end of the fifteenth resistor R15 and a serial data pin SDA of the digital potentiometer U4 is configured as the data input end of the potential adjusting module 108. A collective node between a second end of the sixteenth resistor R16 and a clock input pin SCL of the digital potentiometer U4 is configured as the clock input end of the potential adjusting module 108. An address zero pin A0 of the digital potentiometer U4 is grounded. A first potential wiring pin P0A of the digital potentiometer U4 and a first end of the eighteenth resistor R18 are collectively connected with a second end of the seventeenth resistor R17. A second end of the eighteenth resistor R18 and a second potential wiring pin P0B of the digital potentiometer U4 are collectively connected with a first end of the nineteenth resistor R19. A second end of the nineteenth resistor R19 is configured as the high-level end of potential adjusting module 108. A potential tap pin P0W of the digital potentiometer U4 is configured as the potential adjusting end of the potential adjusting module 108. The digital potentiometer U4 adjusts an internal sliding variable resistor according to the clock signal and the data signal outputted by the main control chip U2, such that the potential at the tap end of the internal sliding variable resistor (i.e., the potential tap pin P0W of the digital potentiometer U4) is changed, and then the voltage tracking and controlling circuit 105 adjusts the output voltage of the isolation transformer 103 by following the potential changes. The digital potentiometer U4 may be a digital potentiometer with a Model No. MCP45X1.

[0031] The current detection module 109 includes : a twentieth resistor R20, a twenty-first resistor R21, a twenty-second resistor R22, a seventh capacitor C7, an eighth capacitor C8, a current detection chip U5, a twenty-third resistor R23, a tenth capacitor C9, a tenth capacitor C10 and a twenty-fourth resistor R24.

[0032] A first end and a second end of the twentieth resistor R20 are configured as the direct current input end and the direct current output end of the current detection module 109 respectively. A first end of the twenty-first resistor R21 and a first end of the twenty-second resistor R22 are connected with a first end and a second end of the twentieth resistor R20 respectively. A second end of the twenty-first resistor R21 and a first end of the seventh capacitor C7 are collectively connected with a positive input pin IN+ of the current detection chip U5. A second end of the twenty-second resistor R22 and a first end of the eighth capacitor C8 are collectively connected with a negative input pin IN- of the current detection chip U5. A collective node between a power pin V+ of the current detection chip U5 and a first end of the ninth capacitor C9 is configured as the power end of the current detection module 109. A vacant pin NC of the current detection chip U5 is suspended. An output pin OUT of the current detection chip U5

is connected with a first end of the twenty-third resistor R23. A second end of the twenty-third resistor R23 is configured as the current feedback end of the current detection module 109. A first end of the tenth capacitor C10 and a first end of the twenty-fourth resistor R24 are collectively connected with the second end of the twenty-third resistor R23. A second end of the seventh capacitor C7, a second end of the eighth capacitor C8, a second end of the ninth capacitor C9, a second end of the tenth capacitor C10, a second end of the twenty-fourth resistor R24, a ground pin GND, a first reference voltage pin REF1 and a second reference voltage pin REF2 of the current detection chip U5 are collectively grounded. The twentieth resistor 20 used as a current detecting resistor samples the output current of the output filtering circuit 104 (i.e., the output current of the power adapter 100), and then the current detecting signal is outputted to the main control chip U2 by the current detection chip U5 according to the voltage between two ends of the twentieth resistor 20. The current detection chip U5 may be a current shunt monitor with a Model No. INA286.

[0033] The voltage detection module 110 includes: a twenty-fifth resistor R25, a twenty-sixth resistor R26, an eleventh capacitor C11, a twelfth capacitor C12, a twenty-seventh resistor R27 and a twenty-eighth resistor R28.

[0034] A first end of the twenty-fifth resistor R25 is configured as the first detecting end of the voltage detection module 110. A collective node of a second end of the twenty-fifth resistor R25, a first end of the twenty-sixth resistor R26 and a first end of the eleventh capacitor C11 is configured as a second output end of the voltage detection module 110. A second end of the twenty-sixth resistor R26 is configured as a second detecting end of the voltage detection module 110. A second end of the eleventh capacitor C11, a first end of the twelfth capacitor C12 and a first end of the twenty-seventh resistor R27 are collectively connected with the second end of the twenty-sixth resistor R26. A collective node of a second end of the twelfth capacitor C12, a second end of the twenty-seventh resistor R27 and a first end of the twenty-eighth resistor R28 is configured as the first output end of the voltage detection module 110. The second end of the twenty-eighth resistor R28 is configured as the third detecting end of the voltage detection module 110.

[0035] The output switch module 111 includes: a twenty-ninth resistor R29, a thirtieth resistor R30, a thirteen capacitor C13, a thirty-first resistor R31, a first NPN type transistor N1, a thirty-second resistor R32, a second NPN type transistor N2, a third diode D3, a voltage stabilizing diode ZD, a thirty-third resistor R33, a thirty-fourth resistor R34, a thirty-fifth resistor R35, a second NMOS transistor Q2 and a third NMOS transistor Q3.

[0036] A first end of the twenty-ninth resistor R29 is configured as the controlled end of

the output switch module 111. A second end of the twenty-ninth resistor R29 and a first end of the thirtieth resistor R30 are collectively connected with a base of the first NPN type transistor N1. A first end of the thirteenth capacitor C13, a first end of the thirty-first resistor R31 and a first end of the thirty-second resistor R32 are collectively connected with a cathode of the third diode D3. An anode of the third diode D3 is configured as the power supply end of the output switch module 111. A second end of the thirty-first resistor R31 and a base of the second NPN type transistor N2 are collectively connected with a collector of the first NPN type transistor N1. The second end of the thirty-second resistor R32, a cathode of the voltage stabilizing diode ZD and a first end of the thirty-third resistor R33 are collectively connected with a collector of the second NPN type transistor N2. A second end of the thirtieth resistor R30, a second end of the thirteenth capacitor C13, an emitter of the first NPN type transistor N1, an emitter of the second NPN type transistor N2 and an anode of the voltage stabilizing diode ZD are collectively grounded. A second end of the thirty-third resistor R33, a first end of the thirty-fourth resistor R34, a first end of the thirty-fifth resistor R35, a grid electrode of the second NMOS transistor Q2 and a grid electrode of the third NMOS transistor Q3 are collectively connected. A second end of the thirty-fourth resistor R34 is configured as the ground end of the output switch module 111. A drain electrode of the second NMOS transistor Q2 is configured as the input end of the output switch module 111. A source electrode of the second NMOS transistor Q2 and a second end of the thirty-fifth resistor R35 are collectively connected with a source electrode of the third NMOS transistor Q3. A drain electrode of the third NMOS transistor Q3 is configured as the output end of the output switch module 111. The second NMOS transistor Q2 and the third NMOS transistor Q3 are switched on or off simultaneously so as to turn on or off the direct current output of the power adapter 100.

[0037] Based on the above-mentioned power adapter 100, embodiments of the present disclosure further provide an electronic device. The electronic device includes a battery 201 and is further provided with the above-mentioned power adapter 100.

[0038] In the present disclosure, the power adapter 100 including the power module 106, the main control module 107, the potential adjusting module 108, the current detection module 109, the voltage detection module 110 and the output switch module 111 is provided for the electronic device 200. The main control module 107 determines whether the output current of the power adapter 100 is greater than the current threshold, and determines whether the output voltage of the power adapter 100 is greater than the voltage threshold. If the output current of the power adapter 100 is greater than the current threshold and/or the output voltage of the power adapter 100 is greater than the voltage threshold, the main control module 107 controls the output switch module 111 to turn off the direct current output of the power adapter 100. In addition, if the electronic

device 200 determines that an overcurrent and/or overvoltage occurs in the output of the power adapter 100, and feeds back the charging stop instruction to the main control module 107, the main control module 107 controls the output switch module 111 to turn off the direct current output of the power adapter 100 according to the charging stop instruction, such that the overcurrent and/or overvoltage protection is realized for the battery 201.

[0039] The forgoing description is only directed to preferred embodiments of the present disclosure, but not used to limit the present disclosure. All modifications, equivalents, variants and improvements made within the spirit and principle of the present disclosure shall fall within the protection scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A power adapter, comprising a communication interface through which the power adapter charges a battery in an electronic device and performs a data communication with the electronic device, an EMI filtering circuit, a high-voltage rectifying and filtering circuit, an isolation transformer, an output filtering circuit, and a voltage tracking and controlling circuit, and being characterized at that,

the power adapter further comprises a power module, a main control module, a potential adjusting module, a current detection module, a voltage detection module and an output switch module;

an input end of the power module is connected with a secondary end of the isolation transformer; a power end of the main control module, a power end of the potential adjusting module and a power end of the current detection module are collectively connected with an output end of the power module; both a high-level end of the main control module and a high-level end of the potential adjusting module are connected with a positive output end of the output filtering circuit; a potential adjusting end of the potential adjusting module is connected with the voltage tracking and controlling circuit; a direct current input end of the current detection module is connected with the positive output end of the output filtering circuit; a current feedback end of the current detection module is connected with a current detecting end of the main control module; a clock output end of the main control module is connected with a clock input end of the potential adjusting module; a data output end of the main control module is connected with a data input end of the potential adjusting module; a first detecting end and a second detecting end of the voltage detection module are connected with a direct current output end of the current detection module and a negative output end of the output filtering circuit respectively; a first output end and a second output end of the voltage detection module are connected with a first voltage detecting end and a second voltage detecting end of the main control module respectively; an input end of the output switch module is connected with the direct current output end of the current detection module; an output end of the output switch module is connected with a third detecting end of the voltage detection module; a ground end of the output switch module is connected with the negative output end of the output filtering circuit; a controlled end of the output switch module is connected with a switching control end of the main control module; a power end of the output switch module is connected with the secondary end of the isolation transformer; each of the negative output end of the output filtering circuit, the output end of the output switch module and a first communication end and a second communication end of the main control module is connected

with the communication interface;

the power module obtains power supply from the isolation transformer and provides the power supply for the main control module, the potential adjusting module and the current detection module; when a quick charging is performed on the battery in the electronic device, the potential adjusting module drives the voltage tracking and controlling circuit to adjust an output voltage of the isolation transformer according to a control signal sent by the main control module; the current detection module detects an output current of the power adapter and feeds back a current detecting signal to the main control module, and the voltage detection module detects an output voltage of the power adapter and feeds back a voltage detecting signal to the main control module; the output switch module turns on or off a direct current output of the power adapter according to a switching control signal sent by the main control module;

when a conventional charging or a quick charging is performed on the battery in the electronic device, the main control module determines whether the output current of the power adapter is greater than a current threshold according to the current detecting signal and determines whether the output voltage of the power adapter is greater than a voltage threshold according to the voltage detecting signal; if the output current of the power adapter is greater than the current threshold and/or the output voltage of the power adapter is greater than the voltage threshold, the main control module controls the output switch module to turn off the direct current output of the power adapter;

during the data communication between the main control module and the electronic device, if the electronic device determines that the output current of the power adapter is greater than the current threshold and/or the output voltage of the power adapter is greater than the voltage threshold, and feeds back a charging stop instruction to the main control module, the main control module controls the output switch module to turn off the direct current output of the power adapter according to the charging stop instruction.

2. The power adapter according to claim 1, being characterized at that,

the power module comprises: a first capacitor, a voltage stabilizing chip, a second capacitor, a first inductor, a second inductor, a fist diode, a second diode, a third capacitor, a first resistor and a second resistor;

a collective node of a first end of the first capacitor, an input power pin and an enable pin of the voltage stabilizing chip is configured as the input end of the power module, a second end of the first capacitor and a ground pin of the voltage stabilizing chip are collectively grounded, a switch pin of the voltage stabilizing chip and a first end of the second capacitor are collectively connected with a first end of the first inductor; an inside switch pin of the voltage stabilizing chip and a

second end of the second capacitor are collectively connected with a cathode of the first diode; a feedback voltage pin of the voltage stabilizing chip is connected with a first end of the first resistor and a first end of the second resistor respectively; a second end of the first inductor and a cathode of the second diode are collectively connected with a first end of the second inductor; a collective node formed by collectively connecting a second end of the second inductor, an anode of the first diode, a second end of the first resistor and a first end of the third capacitor is configured as the output end of the power module, an anode of the second diode, a second end of the second resistor and a second end of the third capacitor are collectively grounded.

3. The power adapter according to claim 1, being characterized at that,

the main control module comprises: a main control chip, a third resistor, a reference voltage chip, a fourth resistor, a fifth resistor, a fourth capacitor, a sixth resistor, a seventh resistor, a first NMOS transistor, an eighth resistor, a ninth resistor, a tenth resistor, an eleventh resistor, a twelfth resistor, a thirteenth resistor and a fourteenth resistor;

a power pin of the main control chip is configured as the power end of the main control module; a ground pin of the main control chip is grounded; a first input/output pin of the main control chip is suspended; a first end of the third resistor is connected with the power pin of the main control chip; a second end of the third resistor and a first end of the fourth resistor are collectively connected with a positive terminal of the reference voltage chip; a negative terminal of the reference voltage chip is grounded; a vacant pin of the reference voltage chip U3 is suspended; a second end of the fourth resistor is connected with a second input/output pin of the main control chip; a third input/output pin of the main control chip is configured as the current detecting end of the main control module; a fourth input/output pin of the main control chip is connected with a first end of the fifth resistor; a second end of the fifth resistor and a first end of the fourth capacitor are collectively connected with the power pin of the main control chip; a second end of the fourth capacitor is grounded; a fifth input/output pin of the main control chip is configured as the switching control end of the main control module; a sixth input/output pin of the main control chip is connected with a first end of the sixth resistor; a second end of the sixth resistor and a grid electrode of the first NMOS transistor are collectively connected with a first end of the seventh resistor; a second end of the seventh resistor and a source electrode of the first NMOS transistor are collectively grounded; a drain electrode of the first NMOS transistor is connected with a first end of the eighth resistor; a second end of the eighth resistor is configured as the high-level end of the main control module; a seventh input/output pin and an eighth input/output pin of the main control chip are configured as the clock output end and the data output end of the main control module respectively; a tenth input/output pin and a ninth input/output pin of the main control chip

are configured as the first voltage detecting end and the second voltage detecting end of the main control module respectively; an eleventh input/output pin and a twelfth input/output pin of the main control chip are connected with a first end of the ninth resistor and a first end of the tenth resistor respectively; a first end of the eleventh resistor and a first end of the twelfth resistor are connected with a second end of the ninth resistor and a second end of the tenth resistor respectively; a second end of the eleventh resistor and a second end of the twelfth resistor are collectively grounded; a first end of the thirteenth resistor and a first end of the fourteenth resistor are connected with the second end of the ninth resistor and the second end of the tenth resistor respectively; a second end of the thirteenth resistor and a second end of the fourteenth resistor are collectively connected with the power pin of the main control chip; the second end of the ninth resistor and the second end of the tenth resistor are configured as the first communication end and the second communication end of the main control module respectively.

4. The power adapter according to claim1, being characterized at that,

the potential adjusting module comprises: a fifteenth resistor, a sixteenth resistor, a digital potentiometer, a seventeenth resistor, an eighteenth resistor, a fifth capacitor, a sixth capacitor and a nineteenth resistor;

a collective node of a first end of the fifteenth resistor, a first end of the sixteenth resistor, a power pin of the digital potentiometer and a first end of the fifth capacitor is configured as the power end of the potential adjusting module; a second end of the fifth capacitor, a first end of the sixth capacitor, a ground pin of the digital potentiometer and a first end of the seventeenth resistor are collectively grounded; a second end of the sixth capacitor is connected with the power pin of the digital potentiometer; a collective node between a second end of the fifteenth resistor and a serial data pin of the digital potentiometer is configured as the data input end of the potential adjusting module; a collective node between a second end of the sixteenth resistor and a clock input pin of the digital potentiometer is configured as the clock input end of the potential adjusting module; an address zero pin of the digital potentiometer is grounded; a first potential wiring pin of the digital potentiometer and a first end of the eighteenth resistor are collectively connected with a second end of the seventeenth resistor; a second end of the eighteenth resistor and a second potential wiring pin of the digital potentiometer are collectively connected with a first end of the nineteenth resistor; a second end of the nineteenth resistor is configured as the high-level end of potential adjusting module; a potential tap pin of the digital potentiometer is configured as the potential adjusting end of the potential adjusting module.

5. The power adapter according to claim 1, being characterized at that,

the current detection module comprises: a twentieth resistor, a twenty-first resistor, a

twenty-second resistor, a seventh capacitor, an eighth capacitor, a current detection chip, a twenty-third resistor, a tenth capacitor, a tenth capacitor and a twenty-fourth resistor;

a first end and a second end of the twentieth resistor are configured as the direct current input end and the direct current output end of the current detection module respectively; a first end of the twenty-first resistor and a first end of the twenty-second resistor are connected with a first end and a second end of the twentieth resistor respectively; a second end of the twenty-first resistor and a first end of the seventh capacitor are collectively connected with a positive input pin of the current detection chip; a second end of the twenty-second resistor and a first end of the eighth capacitor are collectively connected with a negative input pin of the current detection chip; a collective node between a power pin of the current detection chip and a first end of the ninth capacitor is configured as the power end of the current detection module; a vacant pin of the current detection chip is suspended; an output pin of the current detection chip is connected with a first end of the twenty-third resistor, a second end of the twenty-third resistor is configured as the current feedback end of the current detection module; a first end of the tenth capacitor and a first end of the twenty-fourth resistor are collectively connected with the second end of the twenty-third resistor; a second end of the seventh capacitor, a second end of the eighth capacitor, a second end of the ninth capacitor, a second end of the tenth capacitor, a second end of the twenty-fourth resistor, a ground pin, a first reference voltage pin and a second reference voltage pin of the current detection chip are collectively grounded.

6. The power adapter according to claim 1, being characterized at that,

the voltage detection module comprises: a twenty-fifth resistor, a twenty-sixth resistor, an eleventh capacitor, a twelfth capacitor, a twenty-seventh resistor and a twenty-eighth resistor;

a first end of the twenty-fifth resistor is configured as the first detecting end of the voltage detection module; a collective node of a second end of the twenty-fifth resistor, a first end of the twenty-sixth resistor and a first end of the eleventh capacitor is configured as the second output end of the voltage detection module; a second end of the twenty-sixth resistor is configured as the second detecting end of the voltage detection module; a second end of the eleventh capacitor, a first end of the twelfth capacitor and a first end of the twenty-seventh resistor are collectively connected with the second end of the twenty-sixth resistor; a collective node of a second end of the twelfth capacitor, a second end of the twenty-seventh resistor and a first end of the twenty-eighth resistor is configured as the first output end of the voltage detection module; the second end of the twenty-eighth resistor is configured as the third detecting end of the voltage detection module.

7. The power adapter according to claim 1, being characterized at that,

the output switch module comprises: a twenty-ninth resistor, a thirtieth resistor, a thirteen

capacitor, a thirty-first resistor, a first NPN type transistor, a thirty-second resistor, a second NPN type transistor, a third diode, a voltage stabilizing diode, a thirty-third resistor, a thirty-fourth resistor, a thirty-fifth resistor, a second NMOS transistor and a third NMOS transistor;

a first end of the twenty-ninth resistor is configured as the controlled end of the output switch module; a second end of the twenty-ninth resistor and a first end of the thirtieth resistor are collectively connected with a base of the first NPN type transistor; a first end of the thirteen capacitor, a first end of the thirty-first resistor and a first end of the thirty-second resistor are collectively connected with a cathode of the third diode; an anode of the third diode is configured as the power end of the output switch module; a second end of the thirty-first resistor and a base of the second NPN type transistor are collectively connected with a collector of the first NPN type transistor; a second end of the thirty-second resistor, a cathode of the voltage stabilizing diode and a first end of the thirty-third resistor are collectively connected with a collector of the second NPN type transistor; a second end of the thirtieth resistor, a second end of the thirteenth capacitor, an emitter of the first NPN type transistor, an emitter of the second NPN type transistor and an anode of the voltage stabilizing diode are collectively grounded; a second end of the thirty-third resistor, a first end of the thirty-fourth resistor, a first end of the thirty-fifth resistor, a grid electrode of the second NMOS transistor and a grid electrode of the third NMOS transistor are collectively connected; a second end of the thirty-fourth resistor is configured as the ground end of the output switch module; a drain electrode of the second NMOS transistor is configured as the input end of the output switch module; a source electrode of the second NMOS transistor and a second end of the thirty-fifth resistor are collectively connected with a source electrode of the third NMOS transistor; a drain electrode of the third NMOS transistor is configured as the output end of the output switch module.

8. An electronic device, comprising a battery, and being characterized at, further being provided with the power adapter according to any one of claims 1-7.