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When choosing your wiring setup, just make sure that your inverter does not end up powering your converter-charger. Professional installation is highly recommended and advised! So, you got a brand new inverter for your RV and now it's time to wire it! Here is a good explanation on connecting your inverter to RV's electrical system (and below I will include some diagrams to look through): Best Inverter For An RV/Inverter Installation Options! Now, we are going to discuss the step-by-step wiring procedure of an RV. Inverter Wiring The inverter is a device that converts Direct Current (DC) to Alternating Current (AC). Let's discuss a simple example in which an inverter is connected to a battery bank. Feel free to download the PDF version for greater detail. In the above diagram, three batteries are connected in parallel to each other and power up the inverter's DC terminals. A fuse box is installed on the positive (red) wire. If we connect high capacity and a greater number of batteries to the battery bank, then the time for which we can take power from the batteries is increased. The inverter then changes the power to AC, which is collected from its AC output socket. 2-Way Changeover (Inverter or AC Shore Line Supply to RV) Wiring 2-Way changeover is a switching circuit that changes the output power between two inputs like in this case between the inverter and AC shore power line. The 2-way changeover switch shown in the below diagram is a manual changeover switch. It can be purchased from the market at a very cheap price. The power from the AC shoreline is coming through a circuit breaker. The inverter's live and neutral wires are connected to one of the input terminals of the 2-way changeover switch, while the AC shore power line is on the other input terminal. The AC load of RV is connected to the output terminals of the 2-way changeover switch. The ground wire is connected to the ground terminal or the body of the 2-way changeover switch. The Pdf version is available here. 3-Way Changeover (Inverter, AC Shore Line, AC Generator to RV) The 3-way changeover switch changes the output between three inputs, in this case, we connected the power from the AC shoreline to input 1, the AC generator to input 2, and from the inverter to input 3. We can connect the output to any of these inputs by toggling the switch. The output terminal is further connected to the RV AC load. The power from the AC shoreline and AC generator are coming through their respective circuit breaker. The 3-way changeover switch shown in the below diagram is a manual changeover switch of a specific company, model number is written on the diagram. You can use any changeover switch and wire it up on the same lines. Here is a schematic diagram in PDF and this is a wiring diagram in PDF. Charging the Batteries from AC Shore Line or AC Generator RVs have a battery bank which is used to power the RV appliances. For charging these batteries, the schematic and wiring diagrams are shown below. Here we can use a 2-way changeover switch. We can take power either from the AC shoreline or the AC generator. AC shoreline is connected to input 1 and the AC generator is on input 2 of the changeover switch. The output of the changeover switch is further connected to a converter. A converter is a device that changes the power from Alternating Current (AC) to Direct Current (DC). In order to charge the batteries, we have to connect Direct Current (DC) source to the batteries. Thus a converter serves this purpose. A fuse is installed on the positive (red) wire for safety requirements. You can download a PDF version of this schematic here and here is a wiring diagram in PDF as well. Charging the Batteries from AC Shore Line or AC Generator and Solar We can charge the batteries from the solar system. The schematic and wiring diagrams are shown below. The solar plate's output is connected to the solar charge controller. From the solar charge controller, we have an option to connect the RV DC load. The solar charge controller is further connected through a fuse box to the battery bank. The fuse box is installed on the positive (red) wire. In these diagrams, we have three options to charge the battery bank. These are AC shoreline or AC generator and solar system. Here is a schematic in PDF for this diagram and this is for the wiring diagram (also in PDF). RV Complete Wiring Now we are in a position to discuss the whole RV wiring. In this section, we connected all the above circuits together. The battery bank is charging from the solar system as well as from converter output. The converter can run from either the AC shoreline or from the AC generator. Both sources can be changeable through a 2-way changeover switch. On the AC output side, a 3-way switch is installed which have three input options From AC shoreline From AC generator From AC output of inverter which is taking power from the battery bank. The output of the 3-way changeover switch is connected to the AC load of the RV. The DC load of the RV is connected to the solar charge controller. All the appliances in the RV should be connected in parallel to each other and to the source of the Alternating Current (AC). Here is complete RV wiring in PDF (schematics & wiring). And in this file, you will find ALL the schematics together. How to Select an Inverter for RV? RV (or a Recreational Vehicle) is a type of vehicle that can also be used for living purposes. These types of vehicles are mostly used for recreational purposes and usually have a set of 12-volt batteries or a solar system installed (12 VDC). An inverter is used to turn a 12-volt power supply (that is coming from either batteries or solar) into 110 VAC in the USA (or 220 VAC in some other countries). After installing the inverter in our RV, we will be able to use home appliances (like TV, electric kettle, hairdryer, etc.) that work on the AC power supply. There are basically three inverter types and they differ according to the output wave they produce: 1. Pure Sine Wave Inverters If we analyze the output of this kind of inverter through an oscilloscope, then we will find that the waveform of output is like a graph of . This kind of output provides clean AC power to the devices and does not damage them. These inverters are more expensive than other types that I will be discussing later. It is the same power type that we get from utility companies or from standby generators. 2. Modified Sine Wave Inverters The output of this kind of inverter is NOT a pure sine wave. Its waveform has corners and edges rather than around and smooth lines. It looks more like steps: These inverters are cheaper than pure sine wave inverters and do not supply clean power to the devices. The devices run on this kind of inverters might produce a little noise. 3. Square Wave Inverters The waveform of these inverters, when hooked up to an oscilloscope shows an even bigger difference from a pure sine wave. Its values have an abrupt change from their maximum value to the minimum value. This is what it looks like: This is the cheapest form of inverters that can cause damage to the devices. Appliances produce even greater noise when run on square wave inverters (than on modified wave). Keeping in mind the above types, we can select an inverter by taking into account our budget and the devices to use. One more thing which needs to be resolved is the power of the inverter. To find the power of the inverter, we have to know that how many devices we are going to run on the inverter. Let's take an example, we want to run a T. V, an electric kettle, and a microwave oven. Then we have to find the power of each device and add them up. The total value of power in Watts will be the required power of the inverter: One T. V. (LCD/LED) = around 100 Watt One electric kettle = around 1200 Watt One microwave oven = around 1000 Watt Total Power = 2300 Watt Different models of each device can have different power consumption. The power consumption of each device is written on its manual/brochure. In our example, the maximum power is 2300 Watt. We can find an inverter in the market which has a higher power rating than our calculation. We can select a 3000 Watt pure sine wave inverter of any company for our RV. Here is more information on upgrading your inverter/converter system to an inverter-charger (Replacing the RV Converter with Inverter Charger). Our Team Legal Disclaimer For more than 30 years, the switching power supply has supplanted the transistor linear power supply. The first to appear in the series switching power supply. The main circuit topology is like that of the linear power supply. But, after the power transistor is in the switching state, pulse width modulation (PWM) control technology has developed. It uses to control the switching converter to get PWM switching power supply. It characterizes 20kHz pulse frequency or pulse width modulation. The efficiency of the PWM switching power supply can reach 65%~70%, while the efficiency of the linear power supply is only 30%~40%. In the era of the global energy crisis, it has aroused widespread concern. The linear power supply works at the power frequency. It replaces a PWM switching power supply with a working frequency of 20 kHz, which can save energy. It is known as the 20 kHz revolution in the history of power supply technology development. As ULSI chips continue to shrink in size, power supplies are much larger than microprocessors. Many electronic devices need a smaller and lighter power supply, such as aerospace, submarine, military switching power supplies, and battery-operated portable electronic devices (such as portable calculators, mobile phones, etc.) Therefore, requirements of small size and lightweight are imposed on the switching power supply, including the volume and weight of magnetic components and capacitors. In addition, the switching power supply requirements are higher efficiency, better performance and higher reliability. 12V 10A switching power supply (with schematic and explanation)Ⅱ The Basic Principle of Switching Power Supply2.1 The Basic Principle of PWM Switching Power SupplyIt is quite easy to understand the working process of the switching power supply. In a linear power supply, the power transistor is operating in a linear mode. The PWM switching power supply, unlike a linear power supply, allows the power transistor to flip between on and off states. The volt-ampere product applied to the power transistor is always small in both states (the voltage is low and the current is large when turned on; the voltage is high and the current is small when turned off). The product of volt-ampere on a power device is the loss produced on a power semiconductor device. Compared with linear power supplies, PWM switching power supplies work more efficiently by "chopper", which is to convert the input DC voltage into a pulse voltage with an amplitude equal to the input voltage amplitude. The duty ratio of the pulse is regulated by the controller of the switching power supply. Once the input voltage clamps into an AC square wave, its amplitude can be raised or lowered by the transformer. The number of voltage groups of the output can be increased by increasing the number of secondary windings of the transformer. Finally, a DC output voltage is obtained after these AC waveforms are rectified and filtered. The main purpose of the controller is to ensure that the output voltage is stable, and its working process is very similar to a linear controller. This means that the controller's functional block voltage reference and error amplifier designed to be identical to a linear regulator. They differ in that the output of the error amplifier (error voltage) passes through a voltage pulse conversion unit before driving the power transistor. Switching power supplies have two main modes of operation: forward conversion and boost conversion. Although the arrangement of the various parts differs little, the working process varies greatly and they have different advantages in specific situations. The advantage of the forward converter is that the output voltage has a lower ripple peak than the boost converter, and can output relatively high power. The forward converter can provide several kilowatts of power. Because the boost converter has a high peak current, it is only suited for applications with a maximum power of 150 W. These converters use the smallest components in all topologies, making them popular in low- to medium-power applications. 2.2 Working Principle of Switching Power Supply(1) AC power input is rectified and filtered into DC. (2) Control the switching tube by high-frequency PWM (Pulse Width Modulation) signal, and apply DC to the primary switching transformer. (3) The secondary of the switching transformer induces a high-frequency voltage, which supplies the load through rectification and filtering. (4) The output section of the circuit feeds back to the control circuit via a circuit that controls the PWM duty ratio for a stable output. Figure 1. Switching Power Supply Schematic (20W/12V)Ⅲ Circuit Composition of the Switching Power SupplyThe main circuit of the switching power supply is composed of an input electromagnetic interference filter (EMI), a rectification and filtering circuit, a power conversion circuit, a PWM controller circuit, and an output rectification and filtering circuit. The auxiliary circuit has an input over-voltage protection circuit, an output over-voltage protection circuit, an output over-current protection circuit, and output short-circuits protection circuit. The circuit block diagram of the switching power supply is as follows: Figure 2. Block Diagram of Switching Power Supply Circuit Ⅳ Principle of Input Circuit and Common Circuit4.1 Principle of AC Input Rectification and Filtering Circuit Figure 3. Schematic of Input Filter, Rectifier Circuit ① Lightning Protection Circuit: When there is a lightning strike, high voltage is generated through the power grid. Then the circuit consists of MOV1, MOV2, MOV3, F1, F2, F3 and FDG1. When the voltage applied across the varistor exceeds its operating voltage, its resistance decreases. So the high-voltage energy is consumed on the varistor. If the current is too large, F1, F2, and F3 will burn and protect the next circuit. ② Input Filter Circuit: The double π -type filter network, comprised of C1, L1, C2 and C3, primarily suppresses the electromagnetic noise and clutter signals of the input power source to prevent interference to the power supply, as well as high-frequency clutter generated by the power supply itself from interfering with the power grid. The C5 should be charged when the power is switched on. Due to the high instantaneous current, adding RT1 (thermistor) efficiently prevents the surge current. Because the instantaneous energy is utilized by the resistor RT1, the resistance of RT1 drops after a given time as the temperature rises (RT1 is the negative temperature coefficient component). The energy consumption is quite low at this period, and the subsequent circuit can operate normally. ③ Rectifier Filter Circuit: After the AC voltage is rectified by BRG1, it is filtered by C5 to obtain a relatively pure DC voltage. If the capacity of C5 becomes smaller, the output AC ripple will increase.4.2 Principle of DC Input Filter Circuit Figure 4. DC Input Filter Circuit ① Input Filter Circuit: The double-type filter network, consisting of C1, L1, C2 and C3, primarily suppresses the electromagnetic noise and clutter signals of the input power source to prevent interference to the power supply, as well as high-frequency clutter generated by the power supply itself from interfering with the power grid. L2 and L3 are differential mode inductors, whereas C3 and C4 are safety capacitors. ② An anti-surge circuit is formed by R1, R2, R3, Z1, C6, Q1, Z2, R4, R5, Q2, RT1, and C7. Because of the presence of C6, Q2 does not conduct at the start and the current forms a loop through RT1. When the voltage on C6 is charged to the controlled value of Z1, Q2 turns on. If the C8 leakage or the subsequent circuit is short-circuited, the voltage drop created by the current on RT1 increases at the start, and Q1 is turned on such that Q2 is not turned on without the gate voltage, and RT1 will burn out quickly to protect the subsequent circuit.Ⅴ Power Conversion Circuit5.1 Working Principle of MOS TransistorAt present, the most widely used insulated gate field effect transistor is a MOSFET (MOS transistor), which works by utilizing the electroacoustic effect of the semiconductor surface and is also known as surface field-effect devices. Since its gate is non-conducting, the input resistance can be greatly improved up to 105 ohms. The MOS transistor uses the magnitude of the gate-source voltage to change the amount of induced charge on the semiconductor surface, thereby controlling the drain current. 5.1.1 Common Schematics Figure 5. Power Conversion Circuit 5.1.2 Working Principle R4, C3, R5, R6, C4, D1 and D2 create a buffer and are connected in parallel with the switch MOS transistor to reduce voltage stress of the switch tube, EMI, and secondary breakdown. When the switch tube Q1 is turned off, the transformer's primary winding easily produces spike voltage and spike current. These components, when combined, can effectively absorb the spike voltage and current. The current peak signal measured from R3 is used to control the duty ratio of the current working cycle and hence represents the current limit of the current working cycle. When the voltage on R5 reaches 1V, the UC3842 stops operating and switch tube Q1 immediately switches off. The junction capacitances CGS and CGD in R1 and Q1 create an RC network, and the capacitor's charge and discharge directly affect the switching speed of the switching transistor. If R1 is too small, oscillation and electromagnetic interference will be very large; if R1 is too large, the switching speed of the switching tube will be reduced. Z1 usually restricts the MOS transistor's GS voltage to 18V or less, thereby safeguarding the MOS transistor. Q1's gate-controlled voltage is a saw-toothed wave. The longer the Q1 conduction time is when the duty ratio is higher, the more energy the transformer retains. When Q1 is disconnected, the transformer releases energy via D1, D2, R5, R4, and C3. At the same time, it achieves the purpose of magnetic field reset, which is ready for the transformer's next storage and transmission of energy. The IC adjusts the duty ratio of the saw-shaped wave on pin 6 based on the output voltage and current, thereby stabilizing the machine's output current and voltage. C4 and R6 are spike voltage absorption loops. 5.2 Push-pull Power Conversion Circuit Figure 6. Push-pull Power Conversion Circuit Q1 and Q2 will turn on in turn.5.3 Power Conversion Circuit with Drive Transformer Figure 7. Power Conversion Circuit with Drive Transformer T2 is the drive transformer, T1 is the switching transformer, and TR1 is the current loop.Ⅵ Output Rectifier and Filter Circuit6.1 Forward Rectifier Circuit Figure 8. Forward Rectifier Circuit T1 is a switching transformer whose phase of primary and secondary poles are in phase. D1 is a rectifier diode, D2 is a freewheeling diode, and R1, C1, R2, and C2 are despiking circuits. L1 is a freewheeling inductor, and C4, L2, and C5 form a π-type filter.6.2 Flyback Rectifier Circuit Figure 9. Flyback Rectifier Circuit T1 is a switching transformer with opposite phases of the primary and secondary poles. D1 is a rectifier diode, and R1 and C1 are Despiking circuits. L1 is a freewheeling inductor, R2 is a dummy load, and C4, L2, and C5 form a π-type filter. 6.3 Synchronous Rectifier Circuit Figure 10. Synchronous Rectifier Circuit Working Principle: When the upper end of the transformer's secondary is positive, the current causes Q2 to turn on via C2, R5, R6, and R7; the circuit forms the loop, and Q2 is the rectifier. Because of the reverse bias, the gate Q1 is turned off. When the lower end of the transformer's secondary is positive, the current causes Q1 to turn on via C3, R4, and R2, and Q1 is a freewheeling tube. Because of the reverse bias, the gate Q2 is turned off. C6, L1, and C7 form a π-type filter, and L2 is a freewheeling inductor. Despiking circuits are R1, C1, R9, and C4.Ⅶ Principle of Voltage Regulation Loop7.1 Schematic of Feedback Circuit Figure 11. Schematic of Voltage Feedback Loop Circuit7.2 Working PrincipleWhen the voltage is split by the sampling resistors R7, R8, R10, and VR1, the voltage of pin 3 of U1 rises. When it surpasses the reference voltage of pin 2 of U1, pin 1 of U1 outputs a high level, turning on Q1 and the optocoupler OT1 LED, the phototransistor, and the potential of pin 1 of the UC3842, causing the output duty ratio of pin 6 of U1 to fall and U0 to be decreased. When the output U0 decreases, the voltage of pin 3 of U1 decreases. When it is lower than the reference voltage of pin 2 of U1, pin 1 of U1 outputs a low level, Q1 does not conduct, the optocoupler OT1 LED does not emit light and the phototransistor does not conduct. The potential of pin 1 of the UC3842 rises high, thus changing the output duty cycle of pin 6 of U1 to increases and U0 decreases. Repeatedly, the output voltage is kept stable. Adjusting VR1 can change the output voltage value. The feedback loop is an important circuit that affects the stability of the switching power supply. Feedback resistor capacitance error, leakage, virtual soldering and so on will produce self-oscillation. The fault phenomenon is waveform abnormality, empty or full load oscillation, output voltage instability and so on.Ⅷ Short-circuit Protection Circuit— In the event of an output short circuit, the PWM control circuit can limit the output current to a safe level. It has several methods for implementing the current limiting circuit. Only another part of the circuit will be added if the power limiting current does not operate when it is short-circuited. — There are usually two types of short-circuit protection circuits. The following figure shows a low-power short-circuit protection circuit. Figure 12. Short-circuit Protection Circuit The principle is as follows: When the output circuit is short-circuited, the output voltage disappears, the optocoupler OT1 is not switched on, the voltage of UC3842 pin 1 rises to around 5V, and the voltage division of R1 and R2 exceeds the TL431 reference and causes it to turn on. When the VCC potential of UC3842 pin 7 is pulled low, the IC stops operating. When UC3842 fails, the potential of pin 1 vanishes and TL431 does not switch on. The potential of UC3842 pin 7 rises, and the UC3842 restarts and restarts again and again. When the short circuit is removed, the circuit will immediately resume normal operation. — The figure below is a medium power short-circuit protection circuit. Figure 13. Medium Power Short-circuit Protection Circuit The principle is as follows: When the output is short-circuited, the voltage of UC3842 pin 1 rises, and the potential of U1 pin 3 is greater than that of pin 2. The comparator's pin 1 generates a high potential to charge C1. Pin 7 of U1 produces a low potential when the voltage across C1 exceeds the reference voltage of pin5. When the voltage on UC3842 pin 1 falls below 1V, the UCC3842 stops working. When the output voltage falls below 0V, the circuit restarts. When the short circuit is removed, the circuit resumes normal operation. R2 and C1 are charge and discharge time constants, and when the resistance value is incorrect, the short circuit protection does not work. — The figure below is a common current limiting and short-circuit protection circuit. Figure 14. Current Limiting and Short-circuit Protection Circuit Its working principle is briefly described as follows: The output duty ratio of pin 6 of UC3842 is gradually increased. When the voltage of pin 3 exceeds 1V, the UC3842 is turned off and has no output. — The following figure is a protection circuit for sampling current with a current transformer. It has low power consumption, but high cost and a complicated circuit. Figure 15. A Protection Circuit The working principle is as follows: If the output circuit is short-circuited or the current is too large, the voltage induced by the TR1 secondary coil will be higher. When pin 3 of UC3842 exceeds 1 volt, the UC3842 stops working and repeats. When the short circuit or overload disappears, the circuit recovers itself.Ⅸ Output Current Limiting Protection Circuit Figure 16. Output Current Limiting Protection Circuit The circuit seen in the diagram above is a standard output current limiting protection circuit. Its operation is depicted in the diagram above: When the output current is too high, the voltage across RS (manganese copper wire) rises, and the voltage at pin 3 of U1 exceeds the reference voltage at pin 2. Pin 1 of U1 generates a high voltage, Q1 is activated, and the optocoupler exhibits a photoelectric effect. The voltage on UC3842 pin 1 is reduced, as is the output voltage, fulfilling the goal of output overload current limitation. Ⅹ Principle of Output Overvoltage Protection CircuitWhen the output voltage exceeds the designed value, the output overvoltage protection circuit limits the output voltage to a safe value. When the switching power supply's internal voltage regulation loop fails or the output overvoltage phenomena are produced by the user's improper operation, the overvoltage protection circuit protects to prevent harm to the power equipment of the subsequent circuit. The most common overvoltage protection circuits are as follows:10.1 Thyristor Trigger Protection CircuitWhen the output circuit is short-circuited or over-current, the primary current of the transformer increases, the voltage drop across R3 increases, and the voltage of pin 3 rises. Figure 17. Thyristor Trigger Protection Circuit As shown in the figure above, when the Uo1 output rises and the Zener diode (Z3) breaks through, the control terminal of the SCR1 (SCR1) gets the trigger voltage, so the SCR is turned on. The voltage of Uo2 is short-circuited to the ground, and the overcurrent protection circuit or the short circuit protection circuit will work to stop the operation of the entire power supply circuit. When the output overvoltage phenomenon is eliminated, the control terminal trigger voltage of the thyristor is discharged to the ground through R, and the thyristor is restored to the off state.10.2 Photoelectric Coupling Protection Circuit Figure 18. Photoelectric Coupling Protection Circuit As shown above, when Uo has an overvoltage phenomenon, the Zener diode breaks through and conducts current through the optocoupler (OT2) R6 to the ground, and the LED of the photocoupler lights, thereby making the phototransistor of the photocoupler on. The base of Q1 is electrically turned on, and pin 3 of 3842 is reduced so that the IC is turned off and the operation of the entire power supply is stopped. Uo is zero, and the cycle is repeated.10.3 Output Voltage Limiting Protection CircuitThe output voltage limiting protection circuit is as shown in the figure below. When the output voltage rises, the Zener diode and the optocoupler turn on, and the Q1 base turns on with a driving voltage. The voltage of UC38423 rises, the output decreases, and the Zener tube does not conduct. The voltage of UC38423 is lowered and the output voltage is raised. Repeatedly, the output voltage will stabilize within a range depending on the voltage of the regulator. Figure 19. Output Voltage Limiting Protection Circuit10.4 Output Overvoltage Lockout Circuit Figure 20. Output Overvoltage Lockout Circuit When the output voltage Uo rises, the Zener diode and optocoupler are switched on, and the base of Q2 is electrically turned on, as shown in Figure 19(a). Because Q2 is switched on, the base voltage of Q1 is dropped and turned on as well, and the Vcc voltage keeps Q2 on all the time via R1. R2 and Q1. Pin 3 of the UC3842 is always high and the device stops working. In Figure 19(b), UO rises, and the voltage on U1's pin 3 rises. Because D1 and R1 are present, Pin 1 always produces a high level, and Pin 1 of U1 always outputs a high level. Q1 is always on, and UC3842 pin 1 is always low and quits working.Ⅺ Power Factor Correction Circuit (PFC)Schematic Diagram Figure 21. Power Factor Correction Circuit Working Principle The input voltage, in one way, transmits the PFC inductor through an EMI filter made of L1, L2, L3, and so on, as well as BRG1 rectification. In other words, it is divided by R1 and R2 and then supplied to the PFC controller as an input voltage sampling for adjusting the duty ratio of the controlled signal, i.e. changing the on and off time of Q1 and stabilizing the PFC output voltage. L4 is a PFC inductor that stores energy when Q1 is turned on and releases it when Q1 is turned off. D1 is the start diode, D2 is the PFC rectifier diode, and C6, C7 are the filtered diodes. The PFC voltage is passed on to the next circuit. It is divided by R3 and R4 and then given to the PFC controller as an input voltage sampling for adjusting the duty ratio of the control signal and stabilizing the PFC output voltage in another method.Ⅻ Input Over/Under Voltage Protection CircuitSchematic Figure 22. Input Over/Under Voltage Protection Circuit Working Principle The fundamentals of input over-voltage and under-voltage protection of AC input and DC input switching power supply are extremely similar. The protection circuit's sampling voltage is derived from the input filtered voltage. The sampling voltage is separated in two ways: one by R1, R2, R3, R4, and the other by R1, R2, R3, R4, and then fed to comparator pin 3. If the sampling voltage exceeds the reference voltage of pin 2, pin 1 of the comparator outputs a high signal, causing the main controller to shut down and the power supply to shut down. The other way is divided by R6, R8, R9, R10, and then input to comparator pin 6. If the sampling voltage is less than the reference voltage of pin 5, pin 7 of the comparator produces a high signal, causing the main controller to turn off and the power supply to be turned off.XIII Battery Management13.1 Schematic of Battery Management Figure 23. Schematic of Battery Management The parts in the dotted box A constitute the battery starting and shutdown circuit; the dotted box B is the battery charging linear voltage regulated circuit; the dotted box C is the electronic switching circuit, and the dotted box D is the battery charging current limiting circuit.13.2 Start Principle of BatteryThe input voltage is separated into three routes after being fed from the INPUT and AGND terminals. The first method is supplied directly to the succeeding circuit as well as the battery starting and shutdown circuit through D7. The voltage produced by dividing R28, R27, and R26 activates U3 and the optocoupler OT1. R25 supplies the operating voltage for U3, and R23 and R24 are the optocoupler's current limiting and protective resistors. The power supply supplies a base bias voltage to Q4 via R22, OT1, and D9 after the optocoupler is turned on. R21 is Q4's lower bias resistor. A current runs through the relay RLY1-A's coil, and the relay contact RLY1-B pulls in, connecting the battery BAT to the circuit. When Q4 is turned off, D4 prevents the electromotive force generated by the relay coil from impacting the succeeding circuit, and D5 releases the energy generated by the relay coil, which prevents the electromotive force generated by the relay coil from destroying Q4. 13.3 The Voltage Regulated Principle of Battery ChargingAt the beginning of electrification, since Q3 is not biased and does not conduct, there is no voltage at the positive terminal of D3. The power supply provides voltages to U1 and U2 via voltage drop of R1 and regulation of Z1. R2 and U1 form the reference voltage, R13, R4, R5, R6 and VR1 form the battery voltage detection circuit. When the detection voltage of pin 2 of U2 is lower than the voltage of pin 3, pin 1 outputs a high level, and the bias voltage is supplied to Q2 via R14. Q2 is turned on and Q3 is also turned on. The power supply charges the battery BAT via Q3, D3, and relay contacts RLY1-B and F1. When the detection voltage of pin 2 of U2 is higher than the voltage of pin 3, pin 1 output a low level, Q2 loses the bias voltage and is turned off. Q3 is turned off, the positive terminal of D3 has no voltage and its negative voltage drops. The detection voltage of pin 2 of U2 also decreases. When the detection voltage of pin 2 of U2 is lower than the voltage of pin 3, pin 1 outputs a high level, and Q2 and Q3 are turned on to continue charging. So that the negative terminal voltage of D3 is maintained at a certain set value. Adjusting VR1 can change the charging voltage value.13.4 The Principle of Battery Charging Current Limiting Figure 24. Battery Charging During charging, the current returns to ground (AGND) via Q3, RLY1-B, F1, BAT, and R20. At the beginning of battery charging, because the battery voltage is relatively low, the current flowing through Q3, RLY1-B, F1, BAT, and R20 will increase, and the voltage drop generated on R20 will increase (R20 is the current sampling resistor). The upper terminal S of the resistor R20 is connected to the non-inverting input terminal 5 of U2B via R11, and the inverting input terminal 6 of U2B has a fixed reference voltage. When the voltage drop on R20 exceeds the reference voltage, pin 7 of U2 outputs a high level and provides a bias voltage to Q1 through D2 and R15. And Q1 is thus turned on. After Q1 is turned on, Q2 is turned off due to the loss of the base voltage, which will turn off the output of the linear regulator. No current flows through the loops of Q3, RLY1-B, F1, BAT, and R20, and the voltage drop on R20 disappears. Pin 7 of U2 outputs low level and Q1 is cut off. Q2 and Q3 are turned on to continue charging, so the charging current is limited to a certain set value range. Adjusting R10 and R11 can change the current limit point. 13.5 The Principle of Battery Undervoltage ShutdownWhen the input voltage is not available, the battery voltage is sent to the subsequent circuit and the battery starting and shuts down the circuit via D6. When the battery voltage drops, the voltage of pin 1 of U3 also drops. When the battery voltage drops to the designed shutdown point (that is when the voltage of pin 1 of U3 is lower than 2.5V), U3 does not conduct, OT1 has no photoelectric coupling and Q4 is unbiased and cut off. There is no current flows through the coil of the relay RLY1-A, and the relay contact RLY1-B is disconnected, and the battery BAT is disconnected from the circuit to prevent the battery from being over-discharged and damaged. Changing the resistance of R26 and R27 can change the voltage value when the battery is shut down because of Undervoltage.XIV Intelligent Fan Cooling14.1 Intelligent Heat DissipationThere are numerous techniques to dissipate heat from the switching power supply. One of them is intelligent heat dissipation. It changes the operating voltage of the cooling fan to alter the wind pressure based on the temperature of the power supply in order to achieve the optimum heat dissipation effect and to save energy. The schematic diagram is as follows: Figure 25. Intelligent Heat Dissipation14.2 Working PrincipleThe input voltage is applied to the INPUT terminal (1213V), R6 supplies the operating voltage for U2, and R7 and R8 have the same resistance value. The trigger voltage for TL431 is provided after voltage division so that the reference voltage of point A is +5V; RT1 is a negative temperature coefficient thermistor that is applied to the inverting input terminal 6 of U1 via voltage division of R1 and R2. R5 is the output voltage sampling resistor, which is connected to U1's non-inverting input terminal 5 after being split by R4; Q1 is the electronic switch tube, and the fan voltage is output from the FANOUT terminal. Since Q1 is not turned on at the time of power-on, there is no voltage at point C, and the voltage of pin 6 of U1 is higher than pin 5. Therefore, pin 7 of U1 outputs a low level, Z1 is turned on, Q1 is turned on, and there is the voltage at point C; the emitter of Q1 is connected to the input voltage terminal, so the voltage at point C is approximately equal to the input voltage. After being divided by R5 and R4, it is applied to pin 5 of U1's non-inverting input terminal, and because the voltage of pin 5 is greater than the voltage of pin 6, U1 outputs a high level. Z1 is not conducting, Q1 is not conducting, and there is no voltage output at point C; pin 5's voltage is lower than that of pin 6. Pin 7 of U1 again outputs a low level, causing the voltage of C to remain stable at some value (since the voltage of pin 6 does not vary); that is, the voltage at point C varies with the voltage at point B. At the beginning of the switching power supply operation (or light load operation), the internal temperature is low, the internal resistance of the thermistor RT1 is large, and the voltage at point B is relatively low, so the output voltage at point C is also low, and the speed and wind power of the fan slow down due to the low operating voltage. When the temperature inside the switching power supply is gradually increased (or full load operation), the internal resistance of the thermistor RT1 gradually decreases, and the voltage at point B rises, so the output voltage at point C rises, and the fan speeds up and the wind power increases because the operating voltage rises. When the temperature inside the machine drops, the internal resistance of the thermistor gradually increases, the voltage at point B decreases, and the output voltage at point C also decreases. The fan has a slower rotation speed and a lower wind power due to a lower operating voltage. When the voltage (temperature) at point B rises to a certain level, the voltage of pin 3 of U1 is higher than the reference voltage of pin 2, and pin 1 of U1 outputs a high level and goes back to point B via D1 and R13, so that pin 1 of U1 always outputs a high level, that is, self-locking. The other way will be output to the over-temperature protection circuit via D2 to realize over-temperature protection.XV Current Sharing Technology15.1 What is Current Sharing Technology?In communication equipment or other electrical equipment, to make the system work uninterruptedly, the requirements for the power supply system are very high. In addition to requiring the performance of the power supply itself to be stable, another method is to use the 1+1 backup method, that is, one device is powered in parallel with two power supplies. When one of them is damaged, the other one can continue to supply power to the system. In normal operation, each power supply provides the same energy, that is, the voltage and current they output are basically the same. To make the voltage and current output of each power supply basically the same, the current sharing technology is used. The principle is as shown below: Figure 26. Current Sharing Technology15.2 Working PrincipleA current sampling voltage amplifier is formed by U1A, R1 to R7, C1 to C5, and VR1; a voltage follower is formed by U1B and D1. R10 is a current sharing voltage output resistor; R11 to R14, U2A, and C6 to C10 form a balanced voltage comparator; R15 to R17 and Q1 are electronic switches; R30 to R33, C17, C18, and U2B form an overcurrent protection circuit; R19 to 28, D2, D3, D4, C12 to C14, and Q2 are power supply output voltage regulation loops, of which D2 D3 and R19 D6 is a diode that isolates the output. When the power supply is turned on, the voltage amplifier constituted of +IS and -IS supplied to U1A amplifies the current sampling voltage detected by the current loop or manganese copper wire. The output is separated into two halves after being divided by R5, R6, R7, and VR1. D1 works as an isolation to prevent voltage changes on the current sharing bus from impacting the previous stage circuit, while the other is sent to the overcurrent protection circuit. After passing through the voltage follower, the current sampling voltage is separated into two parts. One is routed through R10 and output as the current sharing signal voltage JL+, while the other is routed through R11 to the balanced voltage comparator built of U2A and compared to the reference voltage of pin 2 of U2. When the voltage on U2's pin 3 is greater than the voltage on pin 2, pin 1 produces a high level. Base Q1 is electrically conducted, and R17 and R18 are integrated into the output voltage sampling circuit, causing the output voltage to grow while the output current drop. The detected current sampling voltage is reduced as well, and so is the current sharing signal voltage JL+. Pin 3 of U2 has a lower voltage than pin 2, while pin 1 outputs a low level. Q1 is disconnected, R17 and R18 are removed from the output voltage sampling circuit, and the output voltage is reduced. Finally, the output voltage and current are stabilized during this cycle. When the two power supplies operate in parallel, the output terminals and current sharing signal lines are connected, as indicated in the picture below. If the output current Io1 of power supply A is more than the output current Io2 of power supply B, then the current sampling voltage of A inside the two power supplies will be greater than B, i.e., JL1+ is greater than JL2+, and JL1+ and JL2+ are linked on the same line (current flow bus). As a result, JL2+ rises, the output voltage rises due to the management of power supply B's internal current sharing circuit, Io2 rises and Io1 falls (load current remains constant); when Io2 is greater than Io1, the control process reverses. This cycle will finally ensure that the output voltage and current of the two power supplies are consistent. Figure 27. Parallel Current Sharing Diagram The function of the circuit composed of Q3, C19, R34 to R36 is that Q3 is turned on when the output voltage is low or the output is under voltage at the initial stage of power supply, so that pin 3 of U2A is at a low level. Pin 1 of U2A outputs a low level, and Q1 is cut off, that is, the current sharing circuit does not work. VR1 can adjust the current sharing signal's voltage value and adjust the output current limit point. XVI Frequently Asked Questions about Switching Power Supply1. What does switching power supply mean? What is a Switching Power Supply? Switching power supplies are designed for high efficiency and small size. They incorporate a switching regulator to convert electrical power efficiently. Switching DC power supplies regulate the output voltage through a process called pulse width modulation (PWM). 2. What is a switching power supply 12v? A switching power supply takes an AC input, but rectifies and filters into DC first, is converted back into AC at some high switching frequency, steps down the voltage with a transformer, then is rectified and filtered into a DC output. 3. How does a switching power supply work? In switching power supply designs, the input voltage is no longer reduced; instead, it's rectified and filtered at the input. Then the voltage goes through a chopper, which converts it into a high-frequency pulse train. Before the voltage reaches the output, it's filtered and rectified once again. 4. What is difference between linear and switching power supply? Linear power supplies deliver DC by passing the primary AC voltage through a transformer and then filtering it to remove the AC component. Switching power supplies feature higher efficiencies, lighter weight, longer hold up times, and the ability to handle wider input voltage ranges. 5. What is the working principle of SMPS? SMPS circuit is operated by switching and hence the voltages vary continuously. The switching device is operated in saturation or cut off mode. The output voltage is controlled by the switching time of the feedback circuitry. Switching time is adjusted by adjusting the duty cycle. 6. How do you build a switch mode power supply? The main design types in SMPS are:AC to DC, where AC mains is given as input and we get a regulated DC at the output,DC to DC Step up converter, where an input DC voltage is stepped up i.e. output voltage is greater than input and. 7. What is a switching power supply adapter? A switching power supply takes an AC input, but rectifies and filters into DC first, is converted back into AC at some high switching frequency, steps down the voltage with a transformer, then is rectified and filtered into a DC output. 8. What is the difference between a switching and regulated power supply? There are two topologies to consider for this goal, linear regulated and switch mode power supplies. Linear regulated is ideal for applications that require low noise, whereas switching power supplies are better suited for handheld devices where battery life and efficiency is important. 9. What are the 4 stages of power supply? Power SuppliesTransformer - steps down high voltage AC mains to low voltage AC.Rectifier - converts AC to DC, but the DC output is varying.Smoothing - smooths the DC from varying greatly to a small ripple.Regulator - eliminates ripple by setting DC output to a fixed voltage. 10. How do I get 24V from 12v power supply? In order to get 24v from a 12v supply, you'll need a "DC-DC converter", also called a "boost" or "step-up" converter. A DC-DC converter or boost converter has a chopper circuit (oscillator) that provides current to an inductor via a diode. The current flows for a bit, and then is cut off. 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Thyristor is a four-layer device that needs only a pulse to make it conducting and thereafter it remains conducting. In its most basic form, a thyristor has three terminals: anode (positive terminal), cathode (negative terminal), and gate (control terminal). The gate controls the flow of current between the anode and cathode. Popular Ariticles Date: 2022.04.09 Category: Thyristor 653 What is a Thyristor? By apogeeweb, thyristor,thyristor definition,what is a thyristor,scr thyristor,thyristor vs scr,thyristor vs transistor,application of a thyristor,types of thyristor CatalogI What Is a Thyristor?Ⅱ How Does a Thyristor Work?Ⅲ Thyristor I-V Characteristics Curves3.1 Thyristor turn-on3.2 Thyristor turn-offⅣ Thyristor Phase ControlⅤ Applications of ThyristorsⅥ Different Types of Thyristors and Their Uses6.1 Thyristors with turn-on capability (Unidirectional control)... 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In electronics, a vacuum tube, an electron tube, or valve, or colloquially, a Vacuum Tube Types What are the types of vacuum tubes? There are a lot of different vacuum tube types, all with their own applications, ch Vacuum Tube Applications What are uses of vacuum tubes? Vacuum tube is used as a switch, amplifier or display screen (CRT). Used as on/off swi What is vacuum tube and its uses? In electronics, a vacuum tube, an electron tube, or valve, or colloquially, a tube, is a device that controls electric current flow in a high vacuum between electrodes to which an electric potential difference has been applied. The simplest vacuum tube, the diode, invented in 1904 by John Ambrose Fleming, contains only a heated electron-emitting cathode and an anode. The basic working principle of a vacuum tube is a phenomenon called thermionic emission. It works like this: you heat up a metal, and the thermal energy knocks some electrons loose. ... When the cathode is heated, and a positive voltage is applied to the anode, electrons can flow from the cathode to the anode. From this page, you can know the complete vacuum tube basics. What are the types of vacuum tubes? There are a lot of different vacuum tube types, all with their own applications, characteristics and construction, most of which fall into four general types: (1) The diode, (2) the triode, (3) the tetrode, and (4) the pentode. This page lists the different vacuum tube types. Different Types Of Vacuum Tubes↪Diode Vacuum TubesOne of the simplest forms of vacuum tubes is the diode.↪Triode Vacuum TubesWith this type of vacuum tube, the electric currents flow from the V+ having a high potential that has been applied on the anode end to the cathode's ground potential.↪Tetrode Vacuum TubesThe main idea behind the creation of the triode is related to the formation of the tetrode. It consists of a fourth electrode known as the screen located between the grid and the anode.↪Pentode Vacuum TubesThis kind of tubes is directly connected to its cathode, using a connection inside the vacuum tube or with an open connection between the matching pins. What are uses of vacuum tubes? Vacuum tube is used as a switch, amplifier or display screen (CRT). Used as on/off switches, vacuum tubes allowed the first computers to perform digital computations. From here we can know vacuum tube or thermionic valve technology that provid the first form of active device used within electronics and they are still used in some specialist applications. For example, this simple device had tremendous implications for sound reproduction, which makes possible the next advancements in sound technology. 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